Essays on Firm Capital Structure and Macroeconomic Policy

by

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Abstract

This dissertation is composed of three chapters. In the first chapter, I investigate how firms' capital structure decisions respond to changes in collateral value, caused by real estate price shock. Through the collateral channel, shocks to the value of real estate can have a significant impact on the firms' borrowing capacity. In this chapter, I provide evidence on this mechanism by using Loan-to-Value (henceforth LTV) ratio caps on mortgages in a number of European countries as policy shocks that affect real estate prices. I conduct a difference-in-difference exercise using a unique and comprehensive micro panel data covering both Large and Small & Medium Enterprises (henceforth SMEs). This allows me to better identify and quantify the effects of policy shocks to the value of firm collateral by distinguishing them from local demand shocks and local general equilibrium effects. I find a significant collateral damage on firms' balance sheets, a consequence of LTV policy shock, which in turn caused i) secured debt to decrease in firms with high collateral value more than in firms with low collateral value, and ii) trade credit use to increase in firms with high collateral value more than in firms with low collateral value. These findings document a new evidence on how firms adjust to shocks to the value of collateral through trade credit use. These findings also highlight that macroprudential policies in one sector–such as LTV ratio caps targeting household sector–might result in an unintended consequence in another sector–such as collateral damage in corporate sector. This is an important caveat that policy makers should consider when implementing macroprudential policy.

In the second chapter, my coauthors and I construct a model of incentives

suggesting that interlocking balance sheets through accounts receivable and accounts payable provide incentives necessary to sustain long production chains. One of the implications of this model is that upstream firms in the production chain have higher accounts receivable. Further, the working capital of upstream firms are relatively more sensitive to the availability of credit. Using a large firm-level data set for 15 European OECD countries and the United States, 2000–2009, combined with sector-level measures of relative position in production chains ("upstreamness"), we find strong empirical support for the model. Lack of credit matters for amplifying recessions in economies with long production chains.

In the third chapter, my coauthors and I present new stylized facts on bank and firm leverage during the period 2000–2009 using internationally comparable micro level data from many countries. We document the following patterns: a) there was an increase in leverage for investment banks prior to the sub-prime crisis; b) there was no visible increase in leverage for the typical commercial bank and non-financial firm; c) off-balance-sheet items constitute a big fraction of assets, especially for large commercial banks in the US, whereas investment banks do not report these items; d) the leverage ratio is procyclical for investment banks and for large commercial banks in the US; e) banks in emerging markets with tighter bank regulation and stronger investor protection experienced significantly less deleveraging during the crisis. The results suggest that excessive risk taking before the crisis was not easily detectable because the risk involved the quality rather than the quantity of assets.

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Chapter 1

The Collateral Channel: Firm Leverage and Real Estate Prices

1.1 Introduction

This chapter investigates how firms' capital structure decisions respond to changes in collateral value, caused by real estate price shock. The contributions of this chapter are twofold. First, using a unique and comprehensive firm-level data, I identify and quantify the impact of a change in the value of real estate assets on firms' debt financing decisions. Second, I provide new evidence on how firms' borrowing capacity, strongly associated with collateral pledging, determines firms' choice between secured and unsecured debt financing. Therefore, this chapter assesses the role of collateral channel in transmitting boom-bust cycles in real estate markets to the corporate sector.

Real estate booms have been often associated with economic and financial busts. As a consequence, academics and policy makers have been trying to understand how these booms are transmitted to the real economy. The relevant theoretical literature suggests that the "collateral channel" might have an important role in transmitting shocks in real estate markets to the real economy:

the bursting of a real estate market bubble adversely affects the value of collaterizable real estate assets. Declining collateral values lead to higher cost of external financing which forces firms to decrease borrowing and lower investment leading to a decline in output (Kiyotaki and Moore (1997)). Although there is a significant body of theoretical literature that suggests the significance of the collateral channel, there has been a limited number of empirical studies that identifies and quantifies its economic impact. This chapter is one of the papers that attempts to fill this gap in the literature.

In recent years, a number of European countries have experienced a huge increase in real estate prices associated with rapid credit growth and lax lending standards. Policy makers recommended that banks should apply maximum loan-to-value ratios on mortgages (henceforth referred to as "LTV ratio caps") with the aim of damping credit growth and price inflation in housing markets.[1] Indeed, tightening of LTV ratio of mortgages led to a slowdown in price inflation in housing markets. Their policy experiment provides an ideal setting: it solves the endogeneity problem typically encountered in this type of study. It is a policy shock that is plausibly exogenous to any individual firm. This policy shock then has a general equilibrium effect on the value of real estate assets through the demand and supply of houses, and it is affecting firm financing decisions through collateral channel.

My hypothesis is that if LTV ratio cap is effective in curbing borrowers' demand by tightening borrowers' capacity to borrow, this will have a negative

[1]See Section 1.2 for further details on policy experiments of LTV ratio cap in European countries.

effect on real estate prices, then firms who had higher valued collateral pre-LTV policy shock should experience a bigger drop after-LTV policy shock in their secured borrowing relative to firms who had lower valued collateral pre-LTV policy shock. In order to test this hypothesis, I develop a difference-in-difference estimation with firm fixed effects. The estimation, by interacting firm collateral with a time dummy that separates the period before and after the LTV policy shock, captures before-after shock difference in secured borrowing of firms with similar collateral on their balance sheet prior the LTV policy shock. The inclusion of firm fixed effects is important because the LTV policy shock might affect different firms differently due to unobserved firm characteristics. For example, if high risk taker firms hold less collateral on average, such firms might be affected differentially from the LTV policy shock. In the estimation, this average affect will be fully absorbed by firm fixed effects, and will not invalidate the identification. The identification will come from the timing of the policy shock interacted with predetermined value of firm collateral, which is not allowed to move with the policy shock.

Using a large sample containing non-financial non-real estate firms, I study the episodes of LTV ratio caps on mortgages in Europe (Bulgaria: 2004–2007, Hungary: 2010–present, The Netherlands: 2008–present, Norway: 2010–present, Sweden: 2010–present, and Turkey: 2010–present). In benchmark difference-in-difference estimation, I regress firm leverage (total debt to total assets) on its determinants where collateral is interacted with LTV dummy. Since this is a dummy that takes value 1 in the year(s) when the LTV ratio cap is in place, it allows me to understand how the impact of collateral on firm leverage is affected by this policy shock through its effect on real estate prices. I find a significant

collateral damage effect on firm leverage after the LTV ratio cap. This effect is different for firms with differential collateral values: the LTV ratio cap decreased leverage in firms with high collateral value by 0.9 percentage points more than in firms with low collateral value. The result is robust to different specifications.

This chapter is related to the recent empirical studies by Gan (2007), Chaney, Sraer, and Thesmar (2012) and Cvijanović (2014) who use local variations in real estate price movements as shocks to the value of collateral to identify the causal impact of financial shocks on firms' decisions. Gan (2007) investigates Japan's land market collapse in early 1990's. Within a difference-in-difference like approach, she estimates pre-shock landholdings in 1989 as an exogenous instrument to identify the effect of the bursting of real estate bubble on the average investment rate during five years after the shock, 1994 to 1998. She shows that land-holding Japanese firms were more affected by the shock than firms with no land. Chaney, Sraer, and Thesmar (2012) and Cvijanović (2014) focus on US real estate price boom between 1993–2006 that resulted in a large dispersion in real estate price movements between US states and cities. They follow an instrumental variables approach to isolate the variation in local real estate prices, which may be endogenous to firms' decisions. They both showed that firms significantly change their decisions in response to collateral value appreciation.

My relative contribution is twofold. First, the difference-in-difference approach and the richness of data set I use allow me to better identify the effects of shocks to collateral values by distinguishing them from local demand

shocks and local general equilibrium effects. One concern with the existing estimates is that the correlation between changes in collateral values and changes in firms' decisions might be observed due to a reverse causality problem: say, in response to increases in investment (accompanied by increases in borrowing), large publicly traded firms may have a significant impact on local real estate prices through increases in local business activity and demand for labor. Indeed, in the existing papers, focusing only on large publicly traded firms might be biasing the estimates. However, by using a comprehensive sample dominated by small firms, I minimize the possibility of such reverse causality problem in the estimation.

There is another concern with existing estimates that unobserved variation within a particular location and year might drive the results. To be precise, consider the possibility that real estate price shocks are actually affecting the balance sheet of consumers, not of firms, and this might drive the results through the changes in local demand. I solve this by using four-digit sector-year fixed effects to control for demand. These effects will absorb the impact of changes in local demand for the four-digit sector that the firms operate in. I assume that most of the changes in local demand derive from narrowly defined sector-specific factors. The identifying assumption requires that firms with high collateral value are subject to similar local demand shocks as firms with low collateral value in the same four-digit sector and any remaining variation in firm specific demand conditions does not vary systematically by the collateral value. I am not the first to control for demand using sector fixed effects (e.g., Nanda and Nicholas (2014) and Acharya, Eisert, Eufinger, and Hirsch (2014)) but to the best of my knowledge, Kalemli-Ozcan, Laeven, and Moreno (2015) and this chapter are the

first to allow these effects to vary at a very fine level of sector classification.

Second, existing papers use only large publicly traded firms as in most of the papers studying investment and capital structure decisions in the literature. Being less financially constrained, such firms are least likely to pledge collateral when they borrow from financial institutions. This might lead to a downward bias of the effect of real estate price shock. However, I develop a unique and comprehensive data set that covers not only large publicly traded firms, but also small and medium private firms. The inclusion of small and medium firms is crucial given the structure of European economies. Europe consists of bank-dominant economies tilted toward externally dependent SMEs, and among all sources of external financing, European firms typically prefer debt to finance working capital and/or fixed capital (e.g., Kalemli-Ozcan, Laeven, and Moreno (2015)).[2][3] Tangible assets have been very often pledged as collateral in business lending, and European banks heavily prefer real-estate as collateral especially for SMEs.[4][5] Therefore, with the inclusion of SMEs, I can obtain more accurate estimates of collateral in the analysis of firms' debt financing decisions, then

[2]According to the recent report of European Commission, across the EU-28 in 2013, some 21.6 million SMEs (firms with less than 250 employees) in the non-financial corporate sector employed 88.8 million people and generated 3,666 trillion euro in terms of value added. In other words, 99 out of every 100 businesses are SMEs, as are 2 in every 3 employees and 58 cents in every euro of value added.

[3]Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015) shows how well the data used in this chapter covers the universe of European firms compared to official statistics from Eurostat along several dimensions. See this paper for further statistics.

[4]One of the recent reports developed by International Finance Corporation states that while land and buildings are widely accepted as collateral for loans, the use of movable collateral (such as inventory, accounts receivable, crops, machinery and equipment) is restricted due to the lack of functioning laws and registries to govern secured transactions. For further details, see Secured Transactions Systems & Collateral Registries Toolkit (2010).

[5]For instance, according to the World Bank Investment Climate Survey of 6,511 firms in 24 European countries, nearly 63% of the loans required collateral, and 77% of these loans are secured by real estate (land, buildings, houses owned by the entrepreneurs). For further details, see http://www.enterprisesurveys.org.

precisely link them to the actual changes in aggregate corporate debt movements.

Turning to the results, I find a significant collateral damage effect on firm leverage both at the micro level and at the aggregate level. The micro estimates I obtain from difference-in-difference estimation provide important insights: tightening of LTV ratios result in a significant collateral damage in firms' balance sheets by lowering real estate prices. This in turn causes a bigger drop in secured lending of SMEs relative to large firms with similar collateral on their balance sheet prior the LTV policy shock. According to the back-of-the-envelope calculation I develop, these micro estimates also show that collateral damage can explain around 16 % of the actual decline in aggregate corporate sector.

The collateral channel also has important implications for the usage of trade credit.[6] According to the "balance-sheet channel," changes in monetary policy have potential impact on firms' ability to borrow by changing the value of collateral (Bernanke and Gertler (1995)). The empirical literature has found that trade credit usage changes as a response to monetary policy shocks and business downturns (e.g., Choi and Kim (2005), Mateut, Bougheas, and Mizen (2006), and Nilsen (2002)). To the best of my knowledge, this chapter is the first to provide evidence on how the usage of trade credit responds to changes in collateral value, caused by real estate price shock. In this chapter, I ask this

[6]There is an extensive literature of both theoretical and empirical papers explaining the existence of trade credit. Some emphasize the transaction motive for trade credit, while others emphasize the financial motivation. There are also many papers that have analyzed whether trade credit and bank loan are substitutes or complements. See Giannetti, Burkart, and Ellingsen (2011), Love (2011), and Uchida, Udell, and Watanabe (2013) for the comprehensive reviews of this literature.

specific question: Did firms that experience a collateral damage after the LTV policy shock turn to trade credit as an alternative source of finance?

The sample used in this chapter represents an ideal setting to answer this question. First, as will be shown later, with the exception of Hungary, trade credit accounts for at least roughly one-fourth of the total debt of a representative firm, and about one-third of the short-term debt. Second, besides trade credit, alternative sources of finance are mostly unavailable to firms of the European countries that I focus on: the development of the stock and bond markets is modest.[7] Then, to the extent that credit to firms is more likely to be rationed by financial institutions, the impact of collateral damage (as a consequence of the LTV policy shock) will be magnified, and the net impact will be determined by the extent to which trade credit use offsets financial credit. According to the results, collateral damage caused debt use on secured basis to decrease in firms with high collateral value by 1.2 percentage points more than in firms with low collateral value, whereas it caused trade credit use to increase in firms with high collateral value by 0.2 percentage points more than in firms with low collateral value. Thus, this result provides a new evidence on how the corporate sector adjusts to collateral shocks through unsecured lending: firms that experienced a collateral damage after the LTV policy shock turned to trade credit, allowing the corporate sector to mitigate the effects of such shocks.

There is an extensive literature that analyzes the role of collateral pledging in determining firms' borrowing capacity. However, due to data limitations, almost all papers in this literature preclude the analyses of SMEs. One of the

[7] As shown later, in Europe, two meaningful sources of external finance are financial loans and trade credit, whereas the proportion of bonds in firm finance is limited.

contributions of this paper then is to incorporate firm heterogeneity in this analysis. Using a sample that consists of both large firms and SMEs, I estimate the effect of asset tangibility as proxy for collateral on borrowing capacity of firms of different sizes. According to the estimation results, the impact of asset tangibility on debt capacity is pronounced across all firms of different sizes, but less pronounced across very small firms (i.e., micro enterprises[8]). This finding suggests that the interpretation of the role of asset tangibility in the determination of firms' borrowing capacity should be done with caution: asset tangibility does not inversely measure the extent of financing constraints, but rather measures firms' ability to pledge collateral. Firms' ability to pledge collateral increases firms' borrowing capacity to the extent that tangible assets on firms' balance sheet are liquid (e.g., Campello and Giambona (2013)).

There is also a growing literature that studies the effectiveness of macro-prudential policies.[9] In this literature, there are several papers that provide evidence on whether LTV and DTI[10] ratio caps are effective in mitigating the negative effects of housing boom by controlling credit growth and asset price inflation (e.g., Crowe, DellAriccia, Igan, and Rabanal (2013), Kuttner and Shim (2013)). While suggestive, these studies come with many caveats. Due to data limitations and/or identification struggles, they are not able to clarify the channels through which an LTV cap reduces systemic risk. This paper highlights one micro-level mechanism through which LTV caps on mortgages limit the positive feedback between asset price inflation and firms' capacity to borrow. Doing so,

[8]Micro enterprises are firms with employees less than 10.

[9]See Claessens (2015), Claessens, Ghosh, and Mihet (2013), and Lim (2011) for a comprehensive review of existing studies.

[10]Debt-to-Income.

this paper provides a new evidence on how macroprudential policies targeting one sector–such as LTV ratio caps in household sector–might result in an unintended consequence in another sector–such as collateral damage in corporate sector. This is an important caveat that policy makers should consider when implementing macroprudential policy.

This chapter proceeds as follows. Section 1.2 reviews the policy experiments with LTV ratios. Section 1.3 presents the details about data. Section 1.4 explains the methodology. Section 1.5 presents empirical analysis. Section 1.6 concludes.

1.2 Policy Experiments with LTV Ratio Cap

In principle, macroprudential policies aim to limit the risk of widespread disruptions to the provision of financial services and thereby minimize the impact of such disruptions on real economy as a whole (Lim (2011)). Among others, LTV, LTI[11] and DSTI[12] caps have increasingly been implemented to reduce systemic risk generated by strong credit growth and credit-driven asset price inflation during boom-bust episodes. The caps are viewed as having macro-prudential impact through restricting the quantity of credit by limiting the funding available for certain borrowers to dampen growth in asset prices. In addition, they enhance the resilience of both the banks and their borrowers.[13]

The caps on LTV ratios are particularly popular in Asian and European countries. According to a survey conducted by the IMF in 2010, 20 out of 49

[11] Loan-to-Income.
[12] Debt-Service-to-Income.
[13] Figure 1.1 depicts the transmission channel of a tightening of the LTV, LTI, and DSTI limits.

countries use caps on LTV ratios as a macro-prudential instrument. Specifically, among 20 countries, 11 countries set fixed caps while 9 countries adopt time-varying caps (Lim (2011)).

LTV ratio cap is a cap on the ratio of the value of the loan (L) relative to the value of the underlying collateral (V). LTV ratio cap imposes a limit on borrowers' capacity to borrow on collateralized lending. LTV ratios are not harmonised under the Capital Requirements Directive (CRD) and/or Capital Requirements Regulation (CRR), and rather are implemented at national discretion. LTV ratio cap can be viewed as a recommendation or restriction of credit standards that banks should follow when issuing loans. Therefore, the explicit LTV limits vary both across types of loan within a country as well as across countries. The LTV limit in an individual country is usually related to the type of loan (commercial versus residential) and currency of the loan (domestic versus foreign currency) with foreign currency mortgages usually being subject to stricter LTV limits. Furthermore, the coverage of institutions to which the explicit LTV limit is applied varies across countries.

I undertake a detailed investigation for this particular policy action. The policy action data set used in this paper draws on a variety of sources. I use data sources from several studies developed by Borio and Shim (2007), Claessens, Ghosh, and Mihet (2013), Claessens (2015), Crowe, DellAriccia, Igan, and Rabanal (2013), Hilbers, Otker-Robe, Pazarbasioglu, and Johnsen (2005), Kuttner and Shim (2013), Lim (2011), Lim, Krznar, Lipinsky, Otani, and Wu (2013), and Srobona, Jaromír Benes, Lund-Jensen, Schmieder, and Severo (2011). Wherever available, I also use the official documents from central banks and supervisory & regulatory authorities including their annual reports and financial stability

reports, press releases, email responses from these institutions. I use these secondary sources to cross-check them with the information available in the above-mentioned studies. Doing so, I obtain full and accurate information on relevant policy actions. The final data set allows me to precisely identify the details of implementation date of the LTV ratio policy in a set of European countries: Bulgaria, Hungary, The Netherlands, Norway, Sweden, and Turkey. The details about the implementation of these policy experiments are indicated in Table 1.1.

Table 1.1: LTV Ratio Policy Experiments

Country	**Authority**	**Dates Active**
Bulgaria	Bulgarian National Bank	June 2004–December 2007
Hungary	Magyar Nemzeti Bank	March 2010–present
Netherlands	Rijksoverheid (Dutch government)	2007–present
Norway	Norges Bank	March 2010–present
Sweden	Finansinspektionen & Sveriges Riksbank	2010–present
Turkey	Banking Regulation and Supervision Agency	December 2010–present

Notes: Table 1.1 reports both the time period and the national authority that associated with the LTV ratio policy.

In the below, I briefly document the background that motivates LTV ratio policy action as well as the details regarding its implementation in the corresponding country.

- **Bulgaria**: Credit to households grew rapidly during transition to EU accession. A credit boom was accompanied by a house price boom in early 2000s. Towards mid 2000s, while the credit risk in corporate sector stabilized, it continued to accelerate in household and mortgage sector.

Thus, Bulgarian National Bank introduced LTV ratio caps on mortgages. To be exact, in June 2004, LTV ratio on mortgages risk-weighted at 50% is lowered to a 70%; and in April 2006 the risk weighting for mortgage loans used in the calculation of the capital adequacy ratio is effectively raised by lowering LTV ratio from 70 % to 50 %.

- **Hungary**: In 2010, a large share of mortgage loans was provided in foreign currency which made unhedged borrowers in the household sector vulnerable to exchange rate volatility. To address the excessive foreign currency lending in household sector, the authorities took some LTV ratio policy actions. To illustrate, in March 2010, the maximum LTV ratio was set at 75, 60 and 45 % for forint, euro and other foreign currency loans, respectively. The relevant LTV limits are somewhat higher for vehicle financing loans and residential real estate leasing (80, 65 and 50 % respectively for forint, euro and other foreign currency loans). This limit applies to all institutions providing financial services in Hungary.

- **The Netherlands**: The recent Dutch housing market slump follows a long period of very rapid growth in property prices. Between 1985 and 2007, house prices rose by a cumulative 228%, while consumer prices increased only 56%. Dutch demand for houses was also boosted by government policy. Traditionally, the Dutch government has pursued a policy of promoting home ownership. This limited access to social housing and continued rise in house prices encouraged households including low-income earners. Banks were quite willing to lend to this group, even at very high LTV ratios (the average LTV ratio was 114 % in 2007). Additionally,

mortgage interest rates were very attractive. They declined from 7.12 % in 1995 to 4.82% in 2007. Market sentiment changed over the course of 2007, triggered by the sub-prime mortgage problems in the United States. Dutch banks also started to question lending standards. Before 2007, banks had substantial leeway in their lending to households. However, in 2007, the banks signed up to "Mortgage Lenders' Code of Conduct." In 2011, for all financial intermediaries under this supervision, the code was tightened introducing an LTV ratio of 104% (plus transfer tax) on mortgages. In combination, LTV limit for new mortgage loans decreases stepwise 1 percentage point per annum from 106% in 2012 to 100% in 2018.

- **Norway**: Household debt (mainly mortgages) reached a high level and was a key risk in Norway. Low unemployment and wealth effects from increases in oil prices helped to boost the accumulation of household debt. Lax lending standards and aggressive mortgage lending practices also played a key role. To address the problem of housing debt, in March 2010, Norges Bank set LTV limit at 90%. According to law, LTV ratios on home equity loans should generally not exceed 75 %. Further, in December 2011, the authority tightened the law by lowering LTV ratio on mortgages to 85%, and lowering LTV ratio on home equity loans to 70 %.

- **Sweden**: The Swedish mortgage market is large. Since the mid-1990s, housing prices have risen and mortgage debts of households have increased substantially. In 2001, mortgages comprised 30 % of the Swedish banks

total lending secured on housing. Although housing prices and indebtedness of households in Sweden temporarily dampened after the recent Global Financial Crisis, they have subsequently continued to rise. To address the risks of excessive household leverage and rising housing prices, Sveriges Riksbank introduced an LTV ratio cap on mortgages in 2010. According to general guideline of Financial Stability Authority (Finansinspektionen), LTV ratio has been decreased to 85 % of a property's value. It applies to all credit institutions providing mortgages, but only covers new loans.

- **Turkey**: After the recent Global Financial Crisis, Turkey observed a rapid increase in domestic demand and credit growth, and increased foreign currency borrowing by banks. In late 2010, Banking Regulation and Supervision Agency applied limits on mortgages in order to curb credit growth and increase credit quality: LTV ratio decreased to 75 % on housing loans, LTV ratio decreased to 50% on commercial real estate loans.

Figures 1.2–1.3 show that tightening of LTV ratio on mortgages led to a slowdown in price inflation in housing markets of all countries I focus on. This policy shock also led to a slowdown in prices in commercial markets as shown in Figure 1.6. I observe such a correlation between the price movements of residential property and commercial property due to the fact that both commercial and residential property use and compete for the same fixed supply of land (DiPasquale and Wheaton (1996)). Therefore, as mentioned above, these policy experiments of LTV ratio cap on mortgages present an ideal setting in order to investigate how firms' debt financing decisions respond to price changes in real

estate markets. I will discuss this in detail in Section 1.4.

1.3 Data

1.3.1 Firm-level Data

In my analysis, I use cross-country firm-level data from ORBIS. ORBIS is a commercial data set compiled by Bureau Van Dijk (BvD) that provides administrative data on millions of firms in Europe. The financial statements are initially collected by local Chambers of Commerce and in turn, is relayed to BvD through some 40 different information providers.

The data set has financial accounting information from detailed, harmonized balance-sheets, income statements and profit/loss accounts of both financial and non-financial firms. This data set is crucially different from other data sets that are commonly-used in the literature such as COMPUSTAT for the United States, COMPUSTAT Global, and Worldscope databases, since 99 percent of the companies in ORBIS are private, whereas former data sets contain mainly information on large listed companies. In ORBIS, only less than 2 percent of the firms are publicly listed (which is also separately marketed under the product called OSIRIS).

As stated in Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015), there are several inherent biases affecting the download process, and a number of irregularities in the raw data, which will result in large data loss unless they are dealt with. Then, I fully follow their detailed instructions in order to construct a database that is nationally representative with minimal missing information.

In order to show how representative the data I use in this paper is, I refer to Table 1.2.[14] This table shows how much of the official gross output data from Eurostat is covered by the firms in ORBIS–AMADEUS data for the total economy for a sample of European countries. These countries refer to the countries with policy experiments of LTV ratio cap on mortgages: Bulgaria, Hungary, The Netherlands, Norway, and Turkey. Each cell is the ratio of value of total output produced by the firms in ORBIS–AMADEUS data relative to value of total output produced as in the official data. For a given country-year, ratios are computed by taking the ratio of aggregated gross output values where aggregated gross output is computed by totalling gross output over common available sectors for which the gross-output related variable is available in both data sets.[15] Missing ratios still appear in some country-year due to missing Eurostat data. As shown in Table 1.2 with the exception of Netherlands, ORBIS–AMADEUS data can account more than 50 percent of the aggregate output in all countries.

The sample I use in this paper is mainly composed of micro (1–9 employees), small (10–49 employees) and medium (50–249 employees) enterprises that account for a significant fraction of economic activity in Europe and the majority of economic activity in the sample of selected European countries mentioned above. In Table 1.3, each cell corresponds to the share of indicated size category's number of firms in total economy from the relevant data source for the given country in 2010. Number of firms is summed over overlapping sectors

[14]This table is reproduced from Table 6.1 and Table 6.2 of Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015).

[15]See Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015) for further details on the construction of percentages.

with Eurostat SBS data. This table illustrates that the sample is broadly representative in terms of size distribution. This feature is an important difference of this paper relative to the literature that works with both financial and real variables at the firm level. Most of this literature focuses on listed firms that account for less than 1 percent of the observations in the sample.

The main financial variables used in the analysis are total assets, sales, tangible fixed assets, components of debt, cash holdings, inventory, and earnings before interest, taxes, depreciation, and amortization (EBITDA). I transform financial variables to real using CPI with 2005 base and converting to dollars using the end-of-year 2005 dollar/national currency exchange rate. The data set has detailed sector classification (up to four-digit NACE Rev. 2 industry classification). I drop financial firms, real-estate and government-owned firms, and use all the other sectors.[16] I use two different samples in analysis: Full Sample and Permanent Sample. Full sample contains all firms that are present in the database for at least three years before LTV ratio cap policy, and one year when LTV ratio cap is in place. This sample includes unbalanced panels from the following countries with the relevant periods given in parentheses: Bulgaria (1997–2013), Hungary (1997–2012), Netherlands (1997–2012), Norway (2004–2013), Sweden (1998–2013) and Turkey (2003–2012). Permanent sample covers firms from the Full sample without non-consecutive yearly observations (i.e.,which appear, disappear and reappear in the sample). This sample includes balanced panels from the following countries with the relevant periods given in

[16] I also drop firms operating in the sectors outside SNA production boundary (NACE Rev. 2 sectors T & U).

parentheses: Hungary (2004–2012), Netherlands (2000–2012), Norway (2004–2013), Sweden (1999–2012) and Turkey (2005–2012).[17] Tables 1.4–1.5 (A.1–A.2) show the percentages of firms by firm type and country in the Full (Permanent) sample. The firms in each country's sample refer to ones with non-missing value of the variable on which the percentages are based. In the table, each cell corresponds to the share of indicated category's number of firms in total economy of the given country-period (%). In the first two panels, shares are constructed based on firm size, and firm size is measured by the logarithm of real total assets and the number of employees, respectively. In the bottom panel, firms are categorized based on firm age.

1.3.2 Variable Definitions

The measures of debt and firm controls that I examine in capital structure regressions are coming from the intersection of influential papers on the topic over the last two decades. In this section, I firstly provide a detailed discussion about the measures of debt, secondly I define the variables I use as firm controls in the empirical analysis.

There are differences in the composition of total debt, so the type of firm debt analyzed should base on the objective of the analysis. The objective of this analysis is to investigate how changes in firm collateral are related to changes in firm capital structure decisions. The components of debt have different relationship with firm collateral, for example trade credit use is higher in firms with low levels of pledgable assets whereas secured debt use is higher in firms with

[17] I apply different cleaning steps and quality checks before constructing these two samples. The details regarding all this procedure is available in Section A.1

high levels of pledgable assets. The most appropriate way to analyze different debt measures would be firstly to separate total debt as "secured debt" and "unsecured debt." I do not have matched data at firm-bank level, but I can still make a plausible distinction between secured and unsecured debt. For example, "Loans" and "Trade Creditors," which are sub-accounts of current liabilities in the balance sheet can be treated as secured debt and unsecured debt, respectively. Because loans that are provided by financial institutions heavily require collateral, whereas trade credit that is provided by suppliers does not require collateral.

In addition, total debt includes items like income tax payable, social expenditure payable, pension fund provisions, which are used for other purposes rather than financing, so it may overstate the amount of financial debt. Such items are recorded in balance sheet under the account called "Other Liabilities." However, this account also covers other items such as "Other Short-term Debt," "Other Short-term Creditors," and "Other Long-term Non-Interest Bearing Debt," which are all used for financing purposes. Thus, excluding such types of debt from total debt might underestimate the amount of financial debt. None of these items are reported under "Other Liabilities" as in separate sub-accounts. Given this caveat in reporting of sub-accounts, therefore, in order to avoid any estimation errors, I use different alternative measures as follows: *TotDebt*: The sum of short-term and long-term debt; *FinDebtTOL*: Total debt excluding trade credit; *FinDebt*: Total debt excluding trade credit and other liabilities; *STFinDebt*: Short-term debt from financial institution; *STFinDebtSTOL*: Short-term Debt excluding trade credit, and *TC*: Trade Credit.[18]

[18]The details on the composition of liabilities are available in Section A.2.

The determinants of firm financing decisions I use in the empirical analysis are the ones commonly used in the related literature. To proxy *Collateral*, I consider all types of pledgable assets that firms are able to post as collateral in loan/credit applications. In balance sheets, pledgable assets refer to total book value of tangible fixed assets ("PP&E") which are composite of net book value of land and building, net book value of machinery and equipment, and book value of other tangible assets such as plant and equipment in progress and leased assets. Thus, I define asset tangibility as the ratio of total book value of tangible fixed assets to total book value of assets and use this to measure collateral in leverage analysis. *Profitability* is the ratio of EBITDA to book value of total assets. This variable is used to measure internal finance. To proxy growth opportunities, I use *Sales Growth*, which is defined as the logarithmic difference of real sales (measured in 2005 constant dollars).[19] *Size* is logarithm of book value of total assets (measured in 2005 constant dollars). *Age* is the logarithm of (1+firm age) where firm age in period t is defined as t minus the date of incorporation plus one. To proxy firm liquidity, I use *Cash*, which corresponds to the ratio of cash and cash equivalents to book value of total assets. *Inventory* corresponds to total inventories (raw materials+in progress+finished goods),

[19]Most studies in the related literature use Tobin's Q (measured as the ratio of market value of total assets to book value of total assets) to proxy profitable growth opportunities. Their analysis bases on large US firms who report their cash flow statements reported to COMPUSTAT, so those firms have information on market values. Here, I study capital structure of private firms of different sizes, and private firms do not have information on market values of assets/equity. Thus, Sales Growth is the most appropriate measure for private firms to proxy profitable growth opportunities. Similar to Sales Growth, the ratio of intangible assets to total assets can be considered as an alternative proxy for Tobin's Q. Intangible assets include R&D and advertising expenses and firms are more likely to increase such expenses when they have profitable growth opportunities. Given the limited number of firms reporting information on intangible assets in the data, I instead use Sales Growth in my empirical analysis.

and is normalized by book value of total assets. Table 1.6 shows the descriptive statistics on all these variables used in the empirical analysis. In general there is a good deal of variation that allows me to show both economic and econometric inferences I study in this paper.

1.4 Identification

In this paper, I aim to investigate how firms' debt financing decisions respond to changes in collateral value. I focus on a sample of European countries with policy experiments of LTV ratio caps on mortgages (Bulgaria: 2004–2007, Hungary: 2010–present, The Netherlands: 2008–present, Norway: 2010–present, Sweden: 2010–present, and Turkey: 2010–present). Their policy experience provides an ideal setting for identification. Tightening of LTV ratios on mortgages affects house prices, a policy shock that is plausibly exogenous to any individual firm. This policy shock has a general equilibrium effect through the demand and supply of houses on collateral values, and it is affecting firm financing decisions through collateral channel.

My hypothesis is that if LTV ratio cap is effective in curbing borrowers' demand by tightening borrowers' capacity to borrow, this will have a negative effect on real estate prices, then firms who had higher valued collateral pre-LTV policy shock should experience a bigger drop after-LTV policy shock in their secured borrowing relative to firms who had lower valued collateral pre-LTV policy shock.

In order to test this hypothesis, I develop a difference-in-difference estimation including country-year, sector-year, firm fixed effects. This estimation, by

interacting firm collateral with a time dummy that separates the period before and after the LTV ratio policy shock, captures before-after shock difference in secured borrowing of firms with similar collateral on their balance sheet prior the LTV policy shock. The inclusion of fixed effects is important. These absorb the impact on firms' debt financing decisions of changing country and sector conditions and factors driving both aggregate and local demand. In particular, firm fixed effects will control for unobserved, time-invariant firm characteristics. For example, if high risk taker firms hold less collateral on average, such firms might be affected differentially from the LTV policy shock. In the estimation, this average affect will be fully absorbed by firm fixed effects, and will not invalidate the identification. Further, industry fixed effects at four-digit-level sector codes will absorb time-varying demand conditions, because most of demand fluctuations derive from country- and industry-specific factors, not from firm-specific factors. Any remaining variation in firm specific demand conditions does not vary systematically by the collateral value. The benchmark difference-in-difference equation is:

$$\begin{aligned} \mathrm{y}_{i,s,c,t} &= \beta_1 \mathrm{Collateral}_{i,s,c} \times \mathrm{LTV}_{c,t} + \beta_2 \mathrm{X}_{i,s,c,t} \\ &+ \mu_{c,t} + \mu_{s,t} + \mu_i + \varepsilon_{i,s,c,t}, \end{aligned} \tag{1.1}$$

where the indices i,s,c,t denote a firm, a sector, a country and a year, respectively. I use different debt measures as dependent variables: TotDebt, FinDebtTOL, and TC. X is a matrix containing standard control variables: Sales Growth, Profitability, Size, Inventory, and Cash (see Section 1.3.2 for further details on the construction of variables).

Collateral is a dummy variable that equals one if asset tangibility is higher than the median of the distribution of this variable. I prefer using this variable as in the form of the dummy variable for two reasons. First, given the interaction specification, indicator variable makes the interpretation of the coefficient straightforward by identifying the group of interest clearly. Second, to avoid concerns about selection into becoming high collateral holder a consequence of the policy, Collateral is a predetermined firm-level dummy which bases on the value of asset tangibility three years prior to the application of LTV ratio cap.[20] $\text{LTV}_{c,t}$ a dummy variable that equals to 1 in the year(s) when LTV ratio cap is in place in country c (see reference years given in Table 1.1). The interaction variable is the simple multiplication of these two dummy variables.

I include $\mu_{c,t}$ that captures country-year fixed effects, $\mu_{s,t}$ that controls sector-year fixed effects where sectors are classified according to four digit NACE Revision 2 codes. μ_i capture firm-specific effects, and $\varepsilon_{i,s,c,t}$ is the error term. By using firm fixed effects I will be identifying solely from firm changes over time. Therefore, I cannot identify the main effect of Collateral which is absorbed by firm fixed effects because Collateral is a predetermined firm-level dummy variable. The level (direct) effect of policy shock to LTV ratio is absorbed by country-year fixed effects as other time fixed effects. Both sector-year and country-year fixed effects will absorb the effects of any other industry and country level shocks as well as the effects of any year.

In this specification, the coefficient of interest is β_1. It captures the treatment

[20] Changes in collateral level from low to high in any years during LTV ratio cap is in place is 13 percent of observations. Collateral is a dummy variable that equals one if asset tangibility is higher than 0.15 at any time during three years prior to the application of LTV ratio cap. 0.15 corresponds to the median of the distribution of asset tangibility.

effect of LTV ratio cap and equals the DD estimate. It multiplies the interaction term, which can be interpreted as dummy variable equal to one for the firms who are exposed to the treatment when LTV ratio cap is in place. Given the fact that the LTV ratio policy affects the firms with differential collateral values differently, the coefficient β_1 allows one to measure before-after shock difference in the corresponding debt measure in firms with high collateral value relative to before-after shock difference in firms with collateral value.

1.5 Results

1.5.1 Reconciling Results with Firm Capital Structure Literature

In this section, I first would like to verify that my results are consistent with those of existing papers studying the determinants of firm capital structure decisions. Using a comprehensive panel data that consists of both large firms and SMEs, I revisit stylized capital structure regressions. This exercise represents an important attempt because existing evidence bases mostly on the sample of large publicly traded firms operating in developed countries. Then, I estimate Equation (1.1) without LTV interaction:

$$\mathrm{y}_{i,s,c,t} = \beta_1 X_{i,s,c,t} + \mu_{c,t} + \mu_{s,t} + \mu_i + \varepsilon_{i,s,c,t}, \tag{1.2}$$

where the indices i,s,c,t denote a firm, a sector, a country and a year, respectively. I use different debt measures as dependent variables: TotDebt, FinDebt, FinDebtTOL, and TC. X is a matrix containing standard control variables: Collateral, Sales Growth, Profitability, Size, Inventory, Cash, and Age (see section

1.3.2 for further details on the construction of variables).

The above Equation (1.1) includes fixed effects. Specifically, firm fixed effects will control for unobserved, time-invariant heterogeneity across firms. Industry-year fixed effects at four-digit-level sector codes will absorb time-varying sector specific conditions. Country-year fixed effects will absorb time-varying country specific conditions. As mentioned earlier, since most of the aggregate demand fluctuations derive from country- and industry-specific factors, not from firm-specific factors, country-, industry-year fixed effects will also absorb fluctuations in aggregate demand that might drive the relationship between firm debt financing decisions and any firm controls.

Tables 1.9–1.10 report the estimation results. In order to see whether unobserved heterogeneity drives the results or not, I firstly estimate Equation (1.2) without firm- and industry fixed effects. I use standard leverage measure i.e., TotDebt in the regressions. Columns (1)–(3) show that the estimators pass "fixed-effects stress tests" of Lemmon, Roberts, and Zender (2008) because all firm-level controls are still statistically significant after the inclusion of fixed effects.[21] This result verifies that traditional determinants in capital structure decisions have ability in explaining the variation of leverage both in cross section and within the firm in the time series.

As noted in Section 1.3.2, there are differences in the composition of total debt, so the type of firm debt analyzed should base on the objective of the analysis. The objective of this analysis is to investigate how changes in firm

[21] Lemmon, Roberts, and Zender (2008) argue that the traditional firm-level controls in capital structure decisions become largely insignificant in explaining the variation in firm leverage when the model accounts for time invariant firm effects.

collateral are related to changes in firm capital structure decisions. The components of debt have different relationship with firm collateral, for example trade credit use is higher in firms with low levels of pledgable assets whereas debt use from financial institutions is higher in firms with high levels of pledgable assets. Therefore, I estimate Equation (1.2) individually for different debt measures.

Columns (3)–(6) correspond to debt measures i.e., total debt (TotDebt), total debt excluding trade credit (FinDebtTOL), total debt excluding trade credit and total other liabilities (FinDebt), and trade credit (TC), respectively. As dependent variables in the estimation, they are all normalized by total assets. Further details on the composition of debt measures are given in Section A.2 [22]

The results mirror previous work on related literature. The positive and statistically significant coefficient on "Collateral" in Columns (3)–(5) suggest that if a large fraction of a firm's assets are tangible, those assets can be pledged as collateral diminishing the risk of agency costs on debt. Therefore, firms can issue more debt given the lenders be more willing to supply funds. On the other hand, negative coefficient on collateral in Column (6) suggests that trade credit use is lower in firms with higher levels of collateral.[23] Trade credit is an expensive form of finance, so firms with higher levels of collateral appear to use

[22] As it can be inferred from Table 1.6, there is a significant number of zero observations in terms of bank loans (both short-term and long-term financial loans i.e., STFinDebt, LTFinDebt). In case FinDebt is used as dependent variable in the estimation, the dependent variable is censored from left, and thus Tobit model would be rather an appropriate one. However, within a Tobit model, I cannot control for μ_i and $\mu_{s,t}$ by means of a dummy variable approach (incidental parameters problem), and no Tobit model analogous to the "fixed-effects" Logit estimation exists. Honoré (1992) has proposed a "fixed effects" Tobit estimation that does not impose distributional assumptions. However, it is hard to implement, and partial effects can not be estimated. I therefore do not try his approach. Alternatively, I estimate Tobit model of benchmark leverage regression only with country dummies and compare it with simple pooled OLS. The inferences from these two models are similar.

[23] Trade credit is negatively correlated with collateral levels, supporting the implications of the theoretical model developed in Cunat (2007).

more from other sources of finance.

According to the results, more profitable firms have lower debt of any form, consistent with theoretical predictions in the literature. According to pecking order theory, firms prefer internal funds rather than debt since internal funds have no adverse selection problem (Myers and Majluf (1984)). In other words, highly profitable firms use less debt (more internal equity).

Further, I find a positive and statistically significant coefficient on Sales Growth, suggesting that growing firms use higher debt of all types in order to take advantage of investment opportunities they face. This finding follows Kalemli-Ozcan, Laeven, and Moreno (2015). Using a comprehensive sample of European firms[24], they show that in the run-up to the crisis, a typical European firm increasingly issues debt to utilize profitable investment opportunities (proxied by Sales Growth). The relevant literature is not able to find such a positive relationship between investment opportunities and debt financing. The existing papers mostly utilize Compustat data, representing only a typical large publicly traded company in US, thus fail to provide evidence on SME finance.

Firm size has been empirically found to be positively related to capital structure. Most of the studies in the literature use cross-sectional variation and interpret the positive coefficient on "Size" as larger firms are highly leveraged. However, in this paper, I use within-firm variation and interpret the same coefficient as firms get bigger, they increase debt. The results show a positive coefficient for all types of debt except TotDebt and FinDebtTOL (Columns (3)–(4)). As noted in Section 1.3.2, these two measures are the most comprehensive debt

[24]The structure of their sample is similar to the one I use in this paper since their sample is constructed based on ORBIS–AMADEUS, as in this paper.

measures due to the inclusion of total other liabilities (TOL). This account includes items like income tax payable, social expenditure payable, pension fund provisions, which are used for other purposes rather than financing, thus the extent of such items in these two measures might affect the relationship.

I also study the usage of trade credit within firms by including additional control variables. The result in column (6) shows that firms use more trade credit when they have higher level of inventories, reflecting a positive correlation between firm activity and trade credit use. The result on the "Inventory" variable also could be related to the use of inventories as collateral. The negative coefficient on "Cash" variable suggests that firms increase trade credit use when they face additional liquidity needs.[25]

The first two columns provide results where age is also an explanatory variable in benchmark capital structure equation. In all other regressions, age is not available because it is a firm specific linear time trend, and is absorbed by firm and year fixed effects. Given the caveat in interpreting the coefficient on age in the regressions without firm fixed effects, the negative coefficient on age suggests that as firms age, they issue more equity, but less debt.

The economic effects of firm-level determinants of capital structure decisions are reported in square brackets under standard errors in columns (3)–(6) of Tables 1.9–1.10. The relevant percentages highlight the economic importance of firm controls as determinants of firm debt, indeed collateral (proxied by asset tangibility) appears to be the key determinant of debt of any form. For

[25]In unreported results, I rerun column (6) by including the measures of short-term financial debt (e.g., STFinDebt and STFinDebtSTOL). The negative coefficients on those measures show that firms use more trade credit when they have lower level of short-term finance in other forms i.e. bank loans, reflecting that trade credit can serve as a substitute for short-term financial debt.

example, in column (4), the economic effect of collateral is displayed in terms of percentage change in debt to its sample mean as each regressor increases from the 25th to the 75th percentile (1-IQR change), while all other variables are kept at their sample mean. To be precise, a 1-IQR change in firm collateral leads debt (measured by FinDebtTOL) to increase by 0.089, which is a 17.43% increase relative to the sample mean debt of 0.51.

1.5.2 Collateral and Firm Leverage: The Impact of LTV Ratio Cap Policy

As discussed in Section 1.4 in detail, my hypothesis is that if LTV ratio cap is effective in curbing borrowers' demand by tightening borrowers' capacity to borrow, this will have a negative effect on real estate prices, then firms who had higher valued collateral pre-LTV policy shock should experience a bigger drop after-LTV policy shock in their secured borrowing relative to firms who had lower valued collateral pre-LTV policy shock. In order to test this hypothesis, I estimate Equation (1.1).

Table 1.11 shows the main results. According to the results in column (1), I find a significant collateral damage effect on firm leverage (TotDebt) after LTV ratio cap. This effect is different for firms with differential collateral values: LTV ratio cap decreased leverage in firms with high collateral value by 0.9 percentage point more than in firms with low collateral value.

In order to fully assess the impact of collateral damage on firms' financing decisions, all sources of external finance must be considered. One type of lending might substitute for another type of lending, one type of lender might substitute for another type of lender. Trade credit usage is immanent. As shown in

Table 1.12, with the exception of Hungary, trade credit accounts for at least roughly one-fourth of the total debt of a representative firm and about one-third of the short-term debt. Second, besides trade credit, alternative sources of finance are mostly unavailable to firms of the European countries that I focus on: the development of the stock and bond markets is modest. To be more precise, Figures 1.5–1.6 show the composition of financial liabilities of corporate sector for some European countries I focus on. The percentages are based on official statistics I obtain from Eurostat. According to these percentages, two meaningful sources of external finance are financial loans and trade credit, whereas the proportion of bonds in firm finance is limited. Then, did firms that experienced a collateral damage after LTV ratio cap turn to trade credit as an alternative source of finance?

To the extent that credit to firms are more likely to be rationed by financial institutions, the impact of collateral damage (as a consequence of LTV ratio cap) will be magnified, and the net impact will be determined by the extent to which trade credit use offsets financial credit. According to the results in columns (2)–(3), collateral damage caused debt use on secured basis to decrease in firms with high collateral value by 1.2 percentage points more than in firms with low collateral value, whereas it caused trade credit use to increase in firms with high collateral value by 0.2 percentage points more than in firms with low collateral value.

Columns (5)–(6) correspond to the debt measures divided by total debt as the dependent variable. The evolution of these variables show the relative changes with respect to other debt sources. The results suggest that LTV ratio cap decreased the proportion of secured debt use (FinDebtTOL) in total debt

in firms with high collateral values by 0.5 percentage point more than in firms with low collateral values, whereas it increased the proportion of trade credit use (TC) in total debt in firms with high collateral values by 0.5 percentage point more than in firms with low collateral values. In combination, these results verify the predictions I just stated above.

Does the amount of cash on hand influence trade credit use in the years when LTV ratio cap is in place? If a firm views trade credit as an alternative but expensive source of finance, I should find cash-rich firms increase trade credit to a smaller extent. Therefore, I estimate Equation (1.1) using cash as an indicator of liquidity to test this hypothesis. Cash is a predetermined firm-level dummy which bases on the ratio of cash holding to total assets three years prior to the application of LTV ratio cap.[26] The pre-LTV level of cash is absorbed by firm fixed effects, and thus I can only observe the differential responses to LTV ratio cap. The results reported in columns (4) and (7) suggest that cash-rich firms increase their reliance on credit from suppliers to a smaller extent in the years when LTV cap is in place.

As shown in Table A.6 in the appendix, results are not driven by entry and exit into the sample, and are robust to consider a continuous sample of firms (see Section 1.3.1 for details on the construction of permanent sample). In Table 1.13, I also conduct a placebo test using years prior to LTV ratio cap as the policy years (Bulgaria: 2002–2003, Hungary: 2005–2006, The Netherlands: 2005–2006, Norway: 2008–2009, Sweden: 2005–2006, and Turkey: 2008–2009) and I cannot find that firms change their debt financing decisions as they do

[26] Cash is a firm-level dummy variable that equals one if the ratio of cash holdings to total assets is higher than 0.34 at any time during three years prior to the application of LTV ratio cap. 0.34 corresponds to the 75th of the distribution of this variable.

after-LTV policy shock.

1.5.3 Collateral and Firm Leverage: Average Effects by Different Size Deciles

So far I work with a linear specification to identify the impact of asset tangibility on firm debt financing. This specification delivers useful insights for the average firm in the sample. However, there are issues I need to account for while studying firm capital structure. As mentioned earlier, the industrial structure of the economies studied in this paper are tilted toward SMEs (see e.g., Table 1.3) and SME finance is more complex than large firm finance (Berger and Udell (1998), Berger and Udell (2006)).[27] For this reason, I turn to a specification where the effect of firm collateral on debt is estimated nonlinearly. This is done with a regression of the form:

$$\begin{aligned} \mathrm{y}_{i,s,c,t} &= \beta_1 \mathrm{Collateral}_{i,s,c,t} + \sum_{k=2}^{10} \beta_k \times D_{k,t} \times \mathrm{Collateral}_{i,s,c,t} + \sum_{k=11}^{20} \beta_k \times D_{k,t} \\ &+ \quad + \beta_{21} X_{i,s,c,t} + \mu_{c,t} + \mu_{s,t} + \mu_i + \varepsilon_{i,s,c,t}, \end{aligned} \tag{1.3}$$

where the indices i,s,c,t denote a firm, a sector, a country and a year, respectively. X is a matrix containing standard control variables: Sales Growth, Profitability, Size. $D_{k,t}$ is a time-varying dummy variable that takes value 1 for all firms that fall in decile k of the size distribution in the given year t. In

[27] For example, the finance of very small firms with no track record and no collateral rely on insider funds (from start-up team, family, friends), trade credit and/or angel finance. As firms grow and accumulate collateral and track record, they access to intermediated finance from both equity and debt markets (i.e venture capital and loans from financial institutions). Large firms of known risk and track record issue commercial paper and/or obtain funds from public equity and debt markets in addition to loans from financial institutions.

this way, collateral effect is estimated separately for each size class. Further, $D_{k,t}$ should be interpreted as size-year fixed effects will control for all the time varying differences between firms of different size.

Table 1.14 corresponds to dependent variables i.e. FinDebt, FinDebtTOL, and TC. Collateral×size decile=k is the additional effect of collateral over and above the baseline effect for first decile firms captured by the variable collateral where Collateral is the ratio of tangible fixed assets to total assets. All these effects are reported in the first columns. Latter columns report the overall effect of collateral for a firm of decile k. The corresponding p-value from an F test with the null hypothesis that this effect is zero is given in the square parentheses in bold.

For secured debt obligations (FinDebt, FinDebtTOL), the results show that the impact of asset tangibility on debt capacity is pronounced across all firms of different sizes, but less pronounced across very small and large firms. This finding follows the conventional wisdom. Large firms are typically old, reputable, and less vulnerable to imperfections in credit markets, and hence they borrow with higher LTV ratios (lower collateral) in private debt markets since lenders generally consider them as low-risk borrowers.[28] For example, Berger and Udell (1998, 1995) with US data show that loans to low-risk borrowers are less likely to be collateralized. Similarly, Jimenez, Salas, and Saurina (2006) with Spanish data provide direct evidence of negative association between collateral and a borrower's risk.

[28]In the sample, on average, large firms are 28,5 years old whereas the others in the lower deciles are 14,6 years old. The difference between these means is significant at the 1 percent level.

The results for very small firms[29] suggest that the interpretation of the role of asset tangibility in determination of firms' borrowing capacity should be done with caution: asset tangibility does not inversely measure the extent of financing constraints, but rather measures firms' ability to pledge collateral. Firms' ability to pledge collateral increases firms' borrowing capacity to the extent that tangible assets on firms' balance sheet are liquid (e.g., Campello and Giambona (2013)).

Finally, columns (5) and (6) correspond to unsecured debt obligations (TC). The results show that the impact of asset tangibility on debt capacity is pronounced across all firms of different sizes. However, I do not observe a strong cross-sectional variation as I do in case of secured borrowing. The results suggest that firm heterogeneity (captured by firm size) does not play a strong role in determining trade credit use in firms with similar collateral on their balance sheet. This finding can be explained by the possibility that trade creditors act as "relationship lenders." Trade creditors have proprietary information about their customers and they are better positioned to repossess and resell the supplied goods (e.g., Mian and Smith (1992), McMillan and Woodruff (1999)), thus trade creditors might have an advantage over other lenders in providing credit to firms of all sizes including SMEs.

[29]The firms in bottom deciles (up to 7th decile) correspond to the majority of micro enterprises (0–9 employees), whereas the firms in the middle deciles (7th–9th deciles) correspond to the majority of SMEs (10–249 employees) in the sample. Furthermore, the firms in the bottom deciles are on average younger (13,6 years old) than the firms in the middle deciles (18,5 years old). The difference between these means is significant at the 1 percent level.

1.5.4 Collateral and Firm Leverage: Heterogenous Responses to LTV Ratio Cap Policy

In light of the results I discussed in the previous section, my hypothesis is that if the impact of asset tangibility on debt capacity is less pronounced across very small and large firms, I argue that firms of medium size deciles ("SME") should experience a bigger drop in their secured borrowing relative to firms of bottom and top size deciles ("VerySmall–Large") who had similar collateral damage on their balance sheet after-LTV policy shock.

In order to test this hypothesis, I turn to a triple differences-in-differences specification. I justify this specification by the use of medium-year fixed effects that capture all time varying differences between "SME" firms and "VerySmall–Large" firms. The estimation:

$$\begin{aligned} \mathrm{y}_{i,s,c,t} &= \beta_1 \mathrm{SME}_{i,s,c} \times \mathrm{Collateral}_{i,s,c} \times \mathrm{LTV}_{c,t} \\ &+ \beta_2 \mathrm{Collateral}_{i,s,c} \times \mathrm{LTV}_{c,t} + \beta_2 \mathrm{X}_{i,s,c,t} \\ &+ \mu_{\mathrm{sme},t} + \mu_{c,t} + \mu_{s,t} + \mu_i + \varepsilon_{i,s,c,t}, \end{aligned} \tag{1.4}$$

where the indices i,s,c,t denote a firm, a sector, a country and a year, respectively. X is a matrix containing standard control variables (Sales Growth, Profitability, Size for TotDebt and FinDebtTOL; Sales Growth, Profitability, Size, Inventory and Cash for TC). To avoid selection concerns, I also use predetermined firm-level dummy to define "SME" firms.[30] $\mu_{\mathrm{sme},t}$ are sme-year fixed

[30] SME equals one if the given firm's size (measured by logarithm of real total assets.) is between 75^{th}–95^{th} percentiles of the distribution at any time during the three years prior to the introduction of LTV ratio cap.

effects.

Triple interaction term in Equation (1.4) turns out to be important for identification. To see why, I compare the interpretation of coefficients in Equation (1.1) to those of Equation (1.4). In Equation (1.1), β_1 captures the treatment effect of LTV ratio cap for typical firm holding high level of collateral. This is not the case for β_1 in Equation (1.4) because now this coefficient reflects the treatment effect *only* for a typical "SME" firm with similar collateral value. Therefore, to understand how the treatment effect of LTV ratio cap varies with firm size, one should the compare β_1 to β_2. For example, β_1 compared to β_2 would be the incremental effect of being "SME" firms during the year(s) in which LTV ratio cap is in place.

Table 1.15 reports the estimation results. The results verify the validity of the hypothesis stated above. For example, the results in column (1) show that LTV ratio cap decreased leverage in "SME" firms with high collateral value by 1.2 percentage points more than in "VerySmall–Large" firms with high collateral value. However, firms of different size did not behave differently in terms of trade credit use after they experienced a collateral damage (e.g., in column (3), β_2 is very small i.e., -0.0002). Table 1.16 shows that the results are not driven by "Large"[31] firms, and are robust to the exclusion of large firms.

1.5.5 Aggregate Implications

The results presented in the previous sections suggest a significant collateral damage effect on firms' debt financing decisions after the LTV policy shock. In this section, I will conduct a back-of-the-envelope calculation to link micro

[31] "Large" firms refer to firms of top size deciles.

estimates I obtained from the difference-in-difference estimation to the actual corporate leverage patterns observed in the aggregate data. Doing so, if there observed a decline in aggregate corporate leverage after the LTV policy shock, I will thus be able to gauge how the collateral damage effect contributed to this decline.

To construct aggregate measures, I use official statistics from Eurostat. Eurostat provides country-level balance sheets that have information on non-financial assets, financial assets and financial liabilities. However, the balance sheets I obtain from Eurostat are structured differently than the firm-level balance sheets I use in my analysis. In order to precisely compare the firm-level measures from ORBIS–AMADEUS data with the aggregate measures from Eurostat data, I work on the correspondence of the accounts from these two data sets in detail. [32]

I cannot proceed with the analysis of aggregate implications of LTV policy using the pooled sample of six European countries since Eurostat lacks information for some countries.[33] Then, I proceed with the analysis of Sweden, which has a better coverage in both data sets. I rewrite Equation (1.1) using benchmark leverage measure i.e. TotDebt (the ratio of total debt to total assets):

[32]Statistics on financial balance sheets come from Eurostat. To construct "Total Financial Liabilities" for non-financial corporations, I sum of F3: "Securities other than shares," F4: "Loans," "F6:Insurance premiums", and F7: "Other accounts receivable/payable." This summation would correspond to "TotDebt" in ORBIS–AMADEUS. Next, to construct "Total Assets," I sum of F_AS: "Financial Assets," and T11: "Total Fixed Assets, (net)." This summation would correspond to "TOAS" in ORBIS–AMADEUS. See http://ec.europa.eu/eurostat/data/database?node_code=nasa_f_bs for further details.

[33]For instance, Eurostat does not provide information on non-financial assets for Bulgaria, Norway and Turkey, which prevents me from computing aggregate total assets.

$$\text{TotDebt}_{i,s,t} = \beta_1 \text{Collateral}_{i,s} \times \text{LTV}_t + \beta_2 \text{X}_{i,s,t} + \mu_i + \mu_{s,t} + \varepsilon_{i,s,t}, \quad (1.5)$$

where the indices i,s,t denote a firm, a sector and a year, respectively. X is a matrix containing standard control variables: Sales Growth, Profitability, Size.

In order to sum of collateral damage effect across all Swedish firms (without grouping them based on their collateral values), I first use Collateral as continuous firm-level variable, which is defined by the ratio of tangible fixed assets to total assets. Second, to avoid concerns that the share of tangible fixed assets in total assets might have been changed as a consequence of the policy, I compute firm-level average of this ratio for the 1998–2007 period that excludes all three years prior the introduction of LTV ratio cap in 2010. In the estimation, I cannot identify the main effect of Collateral because Collateral is measured by the firm-level average ratio of tangible assets to total assets, which is absorbed by firm fixed effects. The level (direct) effect of the LTV policy shock is absorbed by country-year fixed effects as other time fixed effects. Sector-year fixed effects will absorb the effects of any other industry shocks as well as the effects of any year.

Third, I sort all firms in ascending order based on Collateral. I denote the before-after LTV policy shock difference in firm leverage as $\Delta\text{TotDebt}_{i,s}$. Then, based on Equation (1.5), the difference in the before-after LTV policy difference in firm leverage in two consecutive firms is expressed in the below:

$$\Delta\text{TotDebt}_{i,s} - \Delta\text{TotDebt}_{i-1,s} = \beta_1(\text{Collateral}_{i,s} - \text{Collateral}_{i-1,s}), \quad (1.6)$$

Further, I define the aggregate effect of the LTV policy shock as:

$$\Delta \text{TotDebt} \quad = \quad \sum_{i \geq 0} \omega_{i,s} \Delta \text{TotDebt}_{i,s}, \tag{1.7}$$

where $\omega_{i,s}$ indicates the share of tangible fixed assets of firm i in aggregate tangible fixed assets.[34] The empirical methodology I use estimates the differential effect of the LTV policy shock across firms with different collateral values. In order to pin down the level effect of this policy shock, I assume that the before-after LTV policy shock difference in firm leverage equals zero for the firm with the lowest collateral value. Then, I have this equality:

$$\Delta \text{TotDebt}_{i,s} \quad = \quad \beta_1 (\text{Collateral}_{i,s} - \text{Collateral}_0) \quad \text{for i} > 0, \tag{1.8}$$

Thus, I find the lower bound of aggregate effect of LTV policy shock on firm leverage by estimating the below equation:

$$\Delta \text{TotDebt}_{i,s} \quad = \quad \beta_1 \sum_{i \geq 0} \omega_{i,s} (\text{Collateral}_{i,s} - \text{Collateral}_0). \tag{1.9}$$

According to the estimation results of Equation (1.5), β_1 equals to -0.032 (see Table 1.17). Further, based on calculations, second term in RHS of equation (1.9) equals to 0.026. Then, aggregate effect of the LTV ratio cap in Swedish corporate sector is -0.08% (=-0.032*0.026).

[34] Statistics on the components total non-financial assets come from Eurostat. They are disaggregated by industry based on NACE Revision 2. Before, summing the values over sectors, I exclude non-overlapping sectors that are not used in the analysis: K: " Financial and insurance activities," L: "Real estate activities," T: "Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use," and "U: Activities of extraterritorial organisations and bodies." To construct "Tangible Fixed Assets (Net)," I take the difference between T11: "Total Fixed Assets (Net)" and T112: "Intangible Fixed Assets." See http://ec.europa.eu/eurostat/data/database?node_code=nama_t20_21_c for further details.

Based on aggregate statistics from Eurostat, I compute the average before-after LTV policy shock difference in aggregate corporate leverage (i.e., the ratio of aggregate corporate financial liabilities to aggregate corporate assets)[35] over the 1998–2013 period. It equals to -0.5% (=0.351-0.356). Thus, the LTV ratio cap that resulted in collateral damage explains 16% (=0.08%/0.5%) of the decline in aggregate corporate leverage.

1.6 Conclusion

This paper investigates how firms' capital structure decisions respond to changes in the value of firm collateral, caused by real estate price shock. Through the collateral channel, shocks to the value of real estate can have a significant impact on the firms' borrowing capacity. I provide evidence on this mechanism by using LTV ratio caps on mortgages in a number of European countries as policy shocks that affect real estate prices. In my empirical analysis, I conduct a difference-in-difference exercise using a unique and comprehensive micro panel data covering both large firms and SMEs. This allows me to better identify and quantify the effects of policy shocks to the value of firm collateral by distinguishing them from local demand shocks and local general equilibrium effects. I find a significant collateral damage effect on firms' debt financing decisions: the LTV policy shock caused secured debt to decrease in firms with high collateral value more than in firms with low collateral value.

Further, I investigate how shocks to the value of firm collateral affect firms' choice between secured and unsecured debt financing. I find that firms that experienced a collateral damage after the LTV policy shock turned to trade

[35] See footnote 31 for details on the construction of this ratio.

credit as an alternative source of finance: collateral damage caused trade credit use to increase in firms with high collateral value more than in firms with low collateral value. These findings document a new evidence on how firms adjust to collateral shocks through trade credit use.

I believe that this paper has important implications on the role of collateral channel in transmitting boom-bust cycles in real estate markets to the corporate sector. The inclusion of SMEs in the analysis is crucial given the structure of European economies. Europe consists of bank-dominant economies tilted toward externally dependent SMEs. Among all sources of external finance, European firms typically prefer debt issuing to finance working capital and/or fixed capital. European banks heavily prefer real-estate as collateral especially for SMEs. Hence, SMEs are highly dependent on real estate assets to access external finance, causing an intimate link between collateral shocks and the aggregate economy. In order to minimize dependency of SME finance on collateral pledging, and broaden SMEs' access to external finance, policy makers should develop alternative policies. For example, SME loan guarantee schemes might enable SMEs to borrow more than would otherwise be possible based on collateral they can pledge. Such policies might then help mitigating the aggregate effects of collateral damage caused by real estate price shock.

This paper also highlights that macroprudential policies in one sector–such as LTV ratio caps on mortgages targeting household sector–might result in an unintended consequence in another sector–such as collateral damage in corporate sector. This is an important caveat that policy makers should consider when implementing macroprudential policy.

Table 1.2: Coverage in Total Economy Based on Gross Output

YEAR	BG	HU	NL	NO	SE
1999		0.79	0.17	0.63	0.52
2000		0.84	0.21	0.63	0.56
2001		0.71	0.2	0.77	0.6
2002	0.57	0.73	0.22	0.79	0.63
2003	0.6	0.66	0.21	0.65	0.65
2004	0.79	0.76	0.22	0.67	0.67
2005	0.83	0.8	0.23	0.69	0.68
2006	0.84	0.81	0.25	0.67	0.71
2007	0.91	0.79	0.25	0.71	0.7
2008	0.94	0.75	0.28	0.59	0.73
2009	0.92	0.87	0.31	0.78	0.87
2010	0.96	0.76	0.35	0.79	0.88
2011	0.88	0.72	0.3	0.72	0.82
2012	0.88	0.82	0.28	0.67	0.76

Notes: Table 1.2 presents the ratios that are calculated based on gross output. The total sample consists of firms that report data with positive values of the corresponding measure (i.e. gross-output). The country codes within these classifications are as follows: BG (Bulgaria), HU (Hungary), NL (Netherlands), NO (Norway), HU (Hungary) and SE (Sweden). BvD provides firm-level information on gross-output for all sectors of a given European country between 1999–2012, however Eurostat SBS data provides information on gross output with the exceptions of some sectors. So, for a given country-year, total economy percentages are computed by taking the ratio of aggregated gross output values where aggregated gross output is computed by totalling gross output over these sectors for which gross-output related variable is available in both data sets. For further details on the construction of percentages, see Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015).

Table 1.3: Size Distribution in terms of Total Economy, 2010

	BG	HU	NL	NO	SE	TR
Panel A: Eurostat SBS						
Micro	91.2	94.6	93.6	91.6	94.5	n.a.
SMEs	8.6	5.2	6.2	8.2	5.4	n.a.
Large	0.2	0.1	0.2	0.2	0.2	n.a.
	BG	HU	NL	NO	SE	TR
Panel B: ORBIS–AMADEUS						
Micro	90.9	77.7	84.8	91.2	91.2	47.9
SMEs	8.9	21.6	14.7	8.2	8.2	46.4
Large	0.2	0.7	0.5	0.6	0.6	5.7

Notes: In Table 1.3, each cell corresponds to the share of indicated size category's number of firms in total economy from the relevant data source for the given country in 2010 (%). Number of firms is summed over overlapping sectors with Eurostat SBS data. In each panel, the first three rows report the percentages from ORBIS-AMADEUS and the next three rows are the same percentages from Eurostat's SBS data. Each column is a different country with the following codes: BG (Bulgaria), NL (Netherlands), NO (Norway), HU (Hungary), RO (Romania), SE (Sweden), and TR (Turkey). Micro corresponds to firms with employees less than 10, SMEs corresponds Small and Medium Enterprises with employees between 10 and 249, and Large corresponds to firms with 250 employees or more. For further details on the construction of percentages, see Kalemli-Ozcan, Sorensen, Villegas-Sanchez, Volosovych, and Yesiltas (2015).

Table 1.4: Percentage of Firms in Full Sample-By Firm Type and Country

Country	Pooled	BG	HU	NL	NO	SE	TR
Period	1997-2013	1997-2013	1997-2013	1997-2012	2004-2012	1998-2013	2003-2012
Panel A: Total Assets							
All	285,204	7,924	54,772	5,212	75,302	137,829	4,165
Small	75.0	83.8	81.2	3.5	72.5	77.8	18.4
	(213,858)	(6,643)	(44,492)	(181)	(54,570)	(107,207)	(765)
Medium	20.1	13.5	15.5	26.4	23.6	19.4	44.3
	(57,338)	(1,069)	(8,508)	(1,376)	(17,740)	(26,798)	(1,847)
Large	4.9	2.7	3.2	70.1	4.0	2.8	37.3
	(14,008)	(212)	(1,772)	(3,655)	(2,992)	(3,824)	(1,553)
Panel B: Employment							
All	235,792	3,850	28,033	4,958	60,456	136,847	1,648
Micro	73.0	47.4	57.9	11.2	70.1	81.0	14.5
	(172,086)	(1,824)	(16,242)	(554)	(42,408)	(110,819)	(239)
SMEs	25.5	42.1	39.9	68.5	29.1	18.4	67.9
	(60,089)	(1,620)	(11,174)	(3,397)	(17,622)	(25,157)	(1,119)
Large	1.5	10.5	2.2	20.3	0.7	0.6	17.6
	(3,617)	(406)	(617)	(1,007)	(426)	(871)	(290)

To be Continued.

Table 1.5: (Cont'd.) Percentage of Firms in Full Sample-By Firm Type and Country

Country	Pooled	BG	HU	NL	NO	SE	TR
Period	1997-2013	1997-2013	1997-2013	1997-2012	2004-2012	1998-2013	2003-2012
Panel C: Age							
All	279,728	3,152	54,142	5,203	75,293	137,773	4,165
Infant	10.2	14.1	9.8	2.9	17.2	6.9	5.2
	(28,568)	(443)	(5,297)	(150)	(12,979)	(9,481)	(218)
Adolescent	11.4	21.5	13.5	4.5	12.5	10.1	6.9
	(31,833)	(677)	(7,310)	(235)	(9,409)	(13,915)	(287)
Middle-aged	69.6	49.0	76.7	43.7	70.2	68.0	67.5
	(194,745)	(1,543)	(41,519)	(2,272)	(52,870)	(93,731)	(2,810)
Old	8.8	15.5	0.0	48.9	0.0	15.0	20.4
	(24,582)	(489)	(16)	(2,546)	(35)	(20,646)	(850)

Notes: Tables 1.4–1.5 show the percentages of firms by firm type and country. The firms in each sample refer to ones with non-missing value of the variable on which the percentages are based. In both tables, each cell corresponds to the share of indicated category's number of firms in total economy of the given country-period (%). In Table 1.4, shares are constructed based on firm size, and firm size is measured by the logarithm of real total assets and the number of employees, respectively. In Table 1.5, firms are categorized based on firm age. In Table 1.4, firm size categories are constructed based on predetermined dummies that each equals one if the firm satisfies the criterion for the corresponding firm category at any time during the three years prior to the introduction of LTV ratio cap: Small equals one if the given firm's size is below 75^{th} percentile of the distribution, Medium equals one if the given firm's size is between 75^{th}–95^{th} percentiles of the distribution, and Large equals one if the given firm's size is above 95^{th} percentile of the distribution. Micro equals one if the given firm has employees less than 10, SMEs equals one if the given firm has employees between 10 and 249, and Large equals one if the given firm has employees higher than 250. In Table 1.5, Infant equals one if the given firm's age is between 0–2, Adolescent equals one if the given firm's age is between 3–4, Middle-aged equals one if the given firm's age is between 5–24, and Old equals one if the given firm's age is 25 or above. Numbers in parentheses refer to the total number of firms with non-missing value of the variable on which the percentages are based.

Table 1.6: Descriptive Statistics: Full Sample

Sample: Full
Period: 1997–2013

Variable	Mean	Median	Std. Dev.	25th Pct.	75th Pct.
TotDebt	0.62	0.61	0.36	0.4	0.8
FinDebt	0.13	0	0.2	0	0.22
FinDebtTOL	0.51	0.48	0.34	0.29	0.67
STFinDebt	0.022	0	0.058	0	0
STFinDebtSTOL	0.32	0.27	0.24	0.15	0.44
TC	0.11	0.057	0.13	0.0067	0.16
Collateral	0.26	0.15	0.26	0.035	0.43
Sales Growth	0.015	0.0079	0.47	-0.12	0.15
Profitability	0.12	0.12	0.19	0.038	0.22
Size	13	13	1.6	12	14
Cash	0.21	0.13	0.22	0.031	0.33
Inventory	0.16	0.05	0.22	0	0.25
Age	2.6	2.7	0.64	2.2	3

Notes: Table 1.6 reports descriptive statistics of main variables used in the empirical analysis for Full Sample. Debt measures are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit; FinDebt: Total debt excluding trade credit and other liabilities; STFinDebt: Short-term debt from financial institution; STFinDebtSTOL: Short-term Debt excluding trade credit, and TC: Trade Credit. Debt measures are all divided by total assets. Further details on the composition of debt measures are given in Section A.2. Collateral is the ratio of total tangible fixed assets to total assets. Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Age is the logarithm of (1+firm age) where firm age in period t that is defined as t minus the date of incorporation plus one. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets.

Table 1.7: Composition of Liabilities-By Firm Type

Sample: Full, 1997–2013								
	All		Small		Medium		Large	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
(% of Total Liabilities)								
STFinDebt	0.03	0	0.023	0	0.045	0	0.063	0
TC	0.11	0.051	0.1	0.04	0.12	0.08	0.11	0.075
STOL	0.54	0.53	0.57	0.58	0.47	0.43	0.46	0.42
LTFinDebt	0.14	0	0.13	0	0.18	0	0.12	0
LTOL	0.11	0	0.11	0	0.095	0	0.16	0.051

Notes: Table 1.7 reports descriptive statistics of debt measures by different firm size groups. Debt measures are defined as follows. STFinDebt: Short-term debt from financial institutions; TC: Trade Credit, STOL: Other Short-term Liabilities, LTFinDebt: Long Term Interest Bearing Debt, LTOL: Other Long-term Liabilities, and TC: Trade Credit. Further details on the composition of debt measures are given in Section A.2

Table 1.8: Cash and Collateral Holdings-By Firm Type

Sample: Full, 1997–2013								
	All		Small		Medium		Large	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
(% of Total Assets)								
Collateral	0.26	0.15	0.25	0.13	0.28	0.18	0.27	0.2
Inventory	0.16	0.05	0.15	0.03	0.17	0.09	0.17	0.12
Cash	0.22	0.13	0.25	0.17	0.15	0.083	0.092	0.035

Notes: Table 1.8 reports descriptive statistics of cash and collateral holdings by different firm size groups. Collateral is the ratio of total tangible fixed assets to total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Debt measures are all divided by total assets.

Table 1.9: Firm Capital Structure Regressions

Sample: Full, 1997–2013

Dep. Var.:	TotDebt (1)	TotDebt (2)	TotDebt (3)	FinDebtTOL (4)	FinDebt (5)	TC (6)
Collateral	0.156***	0.160***	0.157***	0.225***	0.281***	-0.080***
	(0.002)	(0.002)	(0.003)	(0.000)	(0.002)	(0.001)
			[6.58%]	[11.47%]	[56.20%]	[-18.91%]
			[10.00%]	**[17.43%]**	**[85.38%]**	**[-28.15%]**
Profitability	-0.567***	-0.536***	-0.352***	-0.274***	-0.092***	-0.068***
	(0.004)	(0.004)	(0.003)	(0.005)	(0.001)	(0.001)
			[-10.79%]	[-10.21%]	[-13.45%]	[-11.13 %]
			[-10.33%]	**[-9.78%]**	**[-12.88%]**	**[-11.31%]**
Sales Growth	0.074***	0.071***	0.043***	0.026***	0.003***	0.017***
	(0.001)	(0.01)	(0.001)	(0.001)	(0.000)	(0.000)
			[3.26%]	[2.40%]	[1.08%]	[7.11 %]
			[1.87%]	**[1.38%]**	**[0.62%]**	**[4.17%]**
Size	-0.019***	-0.021***	-0.009***	-0.013***	0.032***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.000)
			[-2.32%]	[-4.08%]	[39.38%]	[4.36 %]
			[-2.90%]	**[-5.10%]**	**[49.23%]**	**[5.45%]**
Inventory						0.034***
						(0.002)
						[6.49%]
						[7.73%]
Cash						-0.042***
						(0.001)
						[-8.40 %]
						[-11.38%]
Age	-0.050***	-0.049***				
	(0.002)	(0.001)				

To be continued.

Table 1.10: (Cont'd.) Firm Capital Structure Regressions

Sample: Full, 1997–2013						
Dep. Var.:	TotDebt	TotDebt	TotDebt	FinDebtTOL	FinDebt	TC
	(1)	(2)	(3)	(4)	(5)	(6)
Observations	1,555,196	1,555,196	1,581,186	1,581,186	1,581,186	1,513,978
R^2	0.17	0.21	0.82	0.77	0.81	0.77
Firm Fixed-Effects	no	no	yes	yes	yes	yes
Sector Fixed-Effects	no	yes	no	no	no	no
Country Fixed-Effects	yes	yes	no	no	no	no
Year Fixed-Effects	yes	yes	no	no	no	no
Sector×year Fixed-Effects	no	no	yes	yes	yes	yes
Country×year Fixed-Effects	no	no	yes	yes	yes	yes

Notes: Tables 1.9–1.10 report the results of the estimation of Equation (1.2). The dependent variables are different debt measures i.e., TotDebt, FinDebtTOL, FinDebt, and TC. They are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit; FinDebt: Total debt excluding trade credit and other liabilities, and TC: Trade Credit. Debt measures are all divided by total assets. Further details on the composition of debt measures are given in Section A.2. Collateral is the ratio of total tangible fixed assets to total assets. Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Debt measures are all divided by total assets. Sectors are classified according to four digit NACE Revision 2 codes. Standard errors are heteroskedastic-consistent errors adjusted for clustering across observations of a given firm, and are reported in parentheses. The first figures in square brackets under the t-statistics represent percentage changes in leverage relative to the sample as each continuous regressor increases by its standard deviation, while all other regressors are kept at their sample mean. In the same manner, the second figures in bold represent percentage changes in leverage relative to the sample mean as each continuous regressor increases from 25^{th} to the 75^{th} percentiles, while all other regressors are kept at their sample mean ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 1.11: The Impact of LTV Ratio Cap on Firm Debt Financing Decisions

Sample: Full, 1997–2013

Dependent Variable:	TotDebt	FinDebtTOL	TC	TC	FinDebtTOL	TC	TC
		(divided by total assets)			(divided by total debt)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collateral×LTV	-0.009***	-0.012***	0.002***	0.002***	-0.005***	0.005***	0.004***
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Cash×LTV				-0.001**			-0.003***
				(-3.236)			(-4.868)
Firm Controls	yes	yes	yes	yes	yes	yes	yes
Number of observations	1,581,186	1,581,186	1,513,978	1,513,978	1,581,186	1,513,978	1,513,978
R^2	0.81	0.8	0.77	0.77	0.74	0.73	0.73
Firm Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Sector×year Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Country×year Fixed-Effects	yes	yes	yes	yes	yes	yes	yes

Notes: Table 1.11 reports the results of the estimation of Equation (1.1). The dependent variables are different debt measures i.e., TotDebt, FinDebtTOL, and TC. They are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit, and TC: Trade Credit. Debt measures are divided by total assets and total liabilities in Columns 1–4 and Columns 5–7, respectively. Further details on the composition of debt measures are given in Section A.2. LTV equals to 1 in the year(s) when LTV ratio cap is in place in the corresponding country. Collateral is a dummy variable that equals one if asset tangibility is higher than its median at any time during three years prior to the application of LTV ratio cap. Firm controls are defined as follows: Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Sectors are classified according to four digit NACE Revision 2 codes. Standard errors are heteroskedastic-consistent errors adjusted for clustering across observations of a given firm, and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 1.12: Relative size of Trade Credit (average over firms)

Country	Dataset	Trade credit/assets (%)	Trade credit/total debt (%)	Trade credit/Short term debt (%)
Bulgaria	ORBIS-AMADEUS	19	33	43
Hungary	ORBIS-AMADEUS	3	4	6
Netherlands	ORBIS-AMADEUS	12	19	27
Norway	ORBIS-AMADEUS	15	20	26
Sweden	ORBIS-AMADEUS	11	19	26
Turkey	ORBIS-AMADEUS	23	40	47
United States	NSSBF	17	35	50

Notes: ORBIS–AMADEUS, Bureau Van Dijk database contains data on firms of all sizes for the given European country; NSSBF, National Survey on Small Business Finance 4630 small and medium US firms. ORBIS–AMADEUS covers years 1997-2013 for Bulgaria and Hungary; 1997-2012 for Netherlands; 2004-2012 for Norway; 1998-2013 for Sweden; 2003-2012 for Turkey, and NSSBF is a 1998 cross-section

Table 1.13: The Impact of LTV Ratio Cap on Firm Debt Financing Decisions–Placebo Test

Sample: Full, 1997–2013							
Dependent Variable:	TotDebt	FinDebtTOL	TC	TC	FinDebtTOL	TC	TC
		(divided by total assets)			(divided by total debt)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collateral×LTV	0.003**	0.002**	0.0004	0.0002	0.001	-0.001	-0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cash×LTV				-0.001**			0.001
				(0.000)			(0.001)
Firm Controls	yes	yes	yes	yes	yes	yes	yes
Number of observations	1,133,583	1,133,583	1,102,027	1,102,027	1,133,583	1,102,027	1,102,027
R^2	0.79	0.75	0.76	0.76	0.73	0.72	0.72
Firm Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Sector×year Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Country×year Fixed-Effects	yes	yes	yes	yes	yes	yes	yes

Notes: Table 1.13 reports the results of the estimation of Equation (1.1). The dependent variables are different debt measures i.e., TotDebt, FinDebtTOL, and TC. They are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit, and TC: Trade Credit. Debt measures are divided by total assets and total liabilities in Columns 1–4 and Columns 5–7, respectively. Further details on the composition of debt measures are given in Section A.2. LTV equals to 1 in the year(s) when LTV ratio cap is in place in the corresponding country. Collateral is a dummy variable that equals one if asset tangibility is higher than its median at any time during three years prior to the application of LTV ratio cap. Firm controls are defined as follows: Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Sectors are classified according to four digit NACE Revision 2 codes. Standard errors are heteroskedastic-consistent errors adjusted for clustering across observations of a given firm, and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 1.14: Collateral and Firm Debt: Average Sensitivity by Size Deciles

Sample: Full, 1997–2013						
Dependent Variable:	FinDebt		FinDebtTOL		TC	
	(1)	(2)	(3)	(4)	(5)	(6)
Collateral	0.115***	0.115***	0.094***	0.094***	-0.036***	-0.036***
	(0.004)	**[0.00]**	(0.007)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 2	0.070***	0.185***	-0.002	0.092***	-0.017***	-0.053***
	(0.004)	**[0.00]**	(0.01)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 3	0.113***	0.228***	0.016**	0.110***	-0.031***	-0.067***
	(0.004)	**[0.00]**	(0.008)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 4	0.152***	0.267***	0.040***	0.134***	-0.042***	-0.078***
	(0.005)	**[0.00]**	(0.008)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 5	0.191***	0.304***	0.072***	0.166***	-0.051***	-0.087***
	(0.005)	**[0.00]**	(0.008)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 6	0.223***	0.336***	0.098***	0.192***	-0.055***	-0.091***
	(0.005)	**[0.00]**	(0.008)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 7	0.242***	0.355***	0.112***	0.206***	-0.059***	-0.095***
	(0.005)	**[0.00]**	(0.008)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 8	0.246***	0.359***	0.110***	0.204***	-0.061***	-0.097***
	(0.005)	**[0.00]**	(0.01)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 9	0.237***	0.350***	0.093***	0.187***	-0.057***	-0.093***
	(0.005)	**[0.00]**	(0.008)	**[0.00]**	(0.003)	**[0.00]**
Collateral×s.d. = 10	0.147***	0.138***	0.006	0.100***	-0.035***	-0.071***
	(0.008)	**[0.00]**	(0.01)	**[0.00]**	(0.004)	**[0.00]**
Firm Controls	yes		yes		yes	
Number of observations	1,581,186		1,581,186		1,581,186	
R^2	0.77		0.72		0.77	
Firm Fixed-Effects	yes		yes		yes	
Size decile×year Fixed-Effects	yes		yes		yes	
Sector×year Fixed-Effects	yes		yes		yes	
Country×year Fixed-Effects	yes		yes		yes	

Notes: Table 1.14 reports the results of the estimation of Equation (1.3). The dependent variables are different debt measures i.e. FinDebtTOL, FinDebt, and TC. They are defined as follows. FinDebtTOL: Total debt excluding trade credit; FinDebt: Total debt excluding trade credit and other liabilities, and TC: Trade Credit. Debt measures are all divided by total assets. Further details on the composition of debt measures are given in Section A.2. Collateral is the ratio of tangible fixed assets to total assets. Collateral×s.d.=k is the additional effect of Collateral over and above the baseline effect for first decile firms captured by the variable Collateral, and are reported in the first columns. Latter columns report the overall effect of Collateral for a firm of decile k. The corresponding p-value from an F test with the null hypothesis that this effect is zero is given in the square parentheses in bold. The regression is run with decile specific time-varying time trends (an interaction of the size decile dummy and time trend). See Tables 1.9–1.10 for other details.

Table 1.15: Differential Impact of LTV Ratio cap

Sample: Full, 1997–2013					
Dependent Variable:	TotDebt	FinDebtTOL	TC	FinDebtTOL	TC
	(divided by total assets)			(divided by total debt)	
	(1)	(2)	(3)	(4)	(5)
SME×Collateral×LTV	-0.012***	-0.012***	-0.0002	-0.003**	0.003**
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Collateral×LTV	-0.006***	-0.010***	0.003***	-0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm Controls	yes	yes	yes	yes	yes
Number of Observations	1,581,186	1,581,186	1,513,978	1,581,186	1,513,978
R^2	0.81	0.8	0.77	0.74	0.73
Firm Fixed-Effects	yes	yes	yes	yes	yes
SME×year Fixed-Effects	yes	yes	yes	yes	yes
Sector×year Fixed-Effects	yes	yes	yes	yes	yes
Country×year Fixed-Effects	yes	yes	yes	yes	yes
F-test					
Collateral×LTV	0.00	0.00	0.00	0.00	0.00

Notes: Table 1.15 reports the results of the estimation of Equation (1.4). The dependent variables are different debt measures i.e., TotDebt, FinDebtTOL, and TC. They are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit, and TC: Trade Credit. Debt measures are divided by total assets and total liabilities in Columns 1–3 and Columns 4–5, respectively. Further details on the composition of debt measures are given in Section A.2. LTV equals to 1 in the year(s) when LTV ratio cap is in place in the corresponding country. Collateral is a dummy variable that equals one if asset tangibility is higher than its median at any time during three years prior to the application of LTV ratio cap. SME equals one if the given firm's size (measured by logarithm of real total assets) is between 75^{th}–95^{th} percentiles of the distribution at any time during the three years prior to the introduction of LTV ratio cap. Firm controls are defined as follows: Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Sectors are classified according to four digit NACE Revision 2 codes. Standard errors are heteroskedastic-consistent errors adjusted for clustering across observations of a given firm, and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 1.16: Differential Impact of LTV Ratio cap; Excluding Large Firms

Sample: Full, 1997–2013					
Dependent Variable:	TotDebt	FinDebtTOL	TC	FinDebtTOL	TC
	(divided by total assets)			(divided by total debt)	
	(1)	(2)	(3)	(4)	(5)
SME×Collateral×LTV	-0.013***	-0.012***	-0.0007	-0.003**	0.003**
	(0.002)	(0.002)	(0.01)	(0.001)	(0.001)
Collateral×LTV	-0.006***	-0.010***	0.003***	-0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Firm Controls	yes	yes	yes	yes	yes
Number of Observations	1,496,146	1,496,146	1,429,489	1,496,146	1,429,489
R^2	0.82	0.8	0.77	0.74	0.74
Firm Fixed-Effects	yes	yes	yes	yes	yes
SME×year Fixed-Effects	yes	yes	yes	yes	yes
Sector×year Fixed-Effects	yes	yes	yes	yes	yes
Country×year Fixed-Effects	yes	yes	yes	yes	yes
F-test					
Collateral×LTV	0.00	0.00	0.00	0.00	0.00

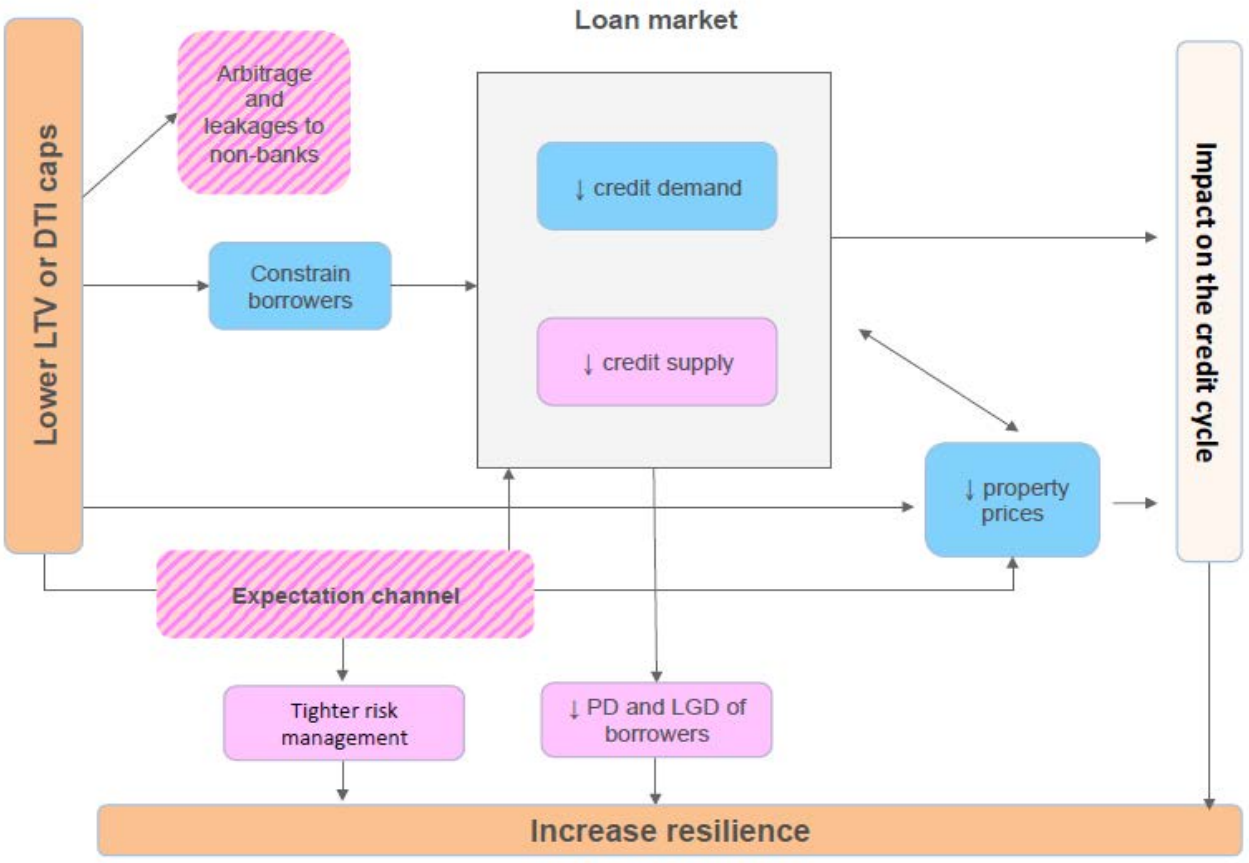
Notes: Table 1.16 reports the results of the estimation of Equation (1.4). The dependent variables are different debt measures i.e., TotDebt, FinDebtTOL, and TC. They are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit, and TC: Trade Credit. Debt measures are divided by total assets and total liabilities in Columns 1–3 and Columns 4–5, respectively. Further details on the composition of debt measures are given in Section A.2. LTV equals to 1 in the year(s) when LTV ratio cap is in place in the corresponding country. Collateral is a dummy variable that equals one if asset tangibility is higher than its median at any time during three years prior to the application of LTV ratio cap. SME equals one if the given firm's size (measured by logarithm of real total assets) is between 75^{th}–95^{th} percentiles of the distribution at any time during the three years prior to the introduction of LTV ratio cap. Firm controls are defined as follows: Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Sectors are classified according to four digit NACE Revision 2 codes. Standard errors are heteroskedastic-consistent errors adjusted for clustering across observations of a given firm, and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 1.17: The Impact of LTV Ratio Cap on Firm Debt Financing Decisions; Sweden

Sample: Full, 1997–2013					
Dependent Variable:	TotDebt	FinDebtTOL	TC	FinDebtTOL	TC
	(divided by total assets)			(divided by total debt)	
	(1)	(2)	(3)	(4)	(5)
Collateral×LTV	-0.032***	-0.059***	0.024***	-0.037***	0.032***
	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)
Firm Controls	yes	yes	yes	yes	yes
Number of Observations	1,041,289	1,041,289	1,030,895	1,041,289	1,030,895
R^2	0.80	0.76	0.74	0.70	0.70
Firm Fixed-Effects	yes	yes	yes	yes	yes
Sector×year Fixed-Effects	yes	yes	yes	yes	yes
Country×year Fixed-Effects	yes	yes	yes	yes	yes
F-test					
Collateral×LTV	0.00	0.00	0.00	0.00	0.00

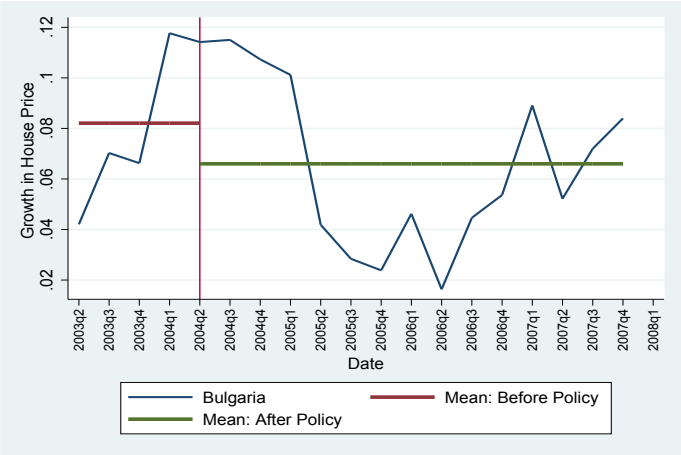
Notes: Table 1.17 reports the results of the estimation of Equation (1.5). The dependent variables are different debt measures i.e., TotDebt, FinDebtTOL, and TC. They are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit, and TC: Trade Credit. Debt measures are divided by total assets and total liabilities in Columns 1–3 and Columns 4–5, respectively. Further details on the composition of debt measures are given in Section A.2. LTV equals to 1 in the year(s) when LTV ratio cap is in place in the corresponding country. Collateral is constructed as firm-level average of the ratio of tangible fixed assets to total assets for the 1998–2007 period. Firm controls are defined as follows: Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Sectors are classified according to four digit NACE Revision 2 codes. Standard errors are heteroskedastic-consistent errors adjusted for clustering across observations of a given firm, and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Figure 1.1: Transmission Channels of A Tightening of the LTV, LTI and DSTI Limits

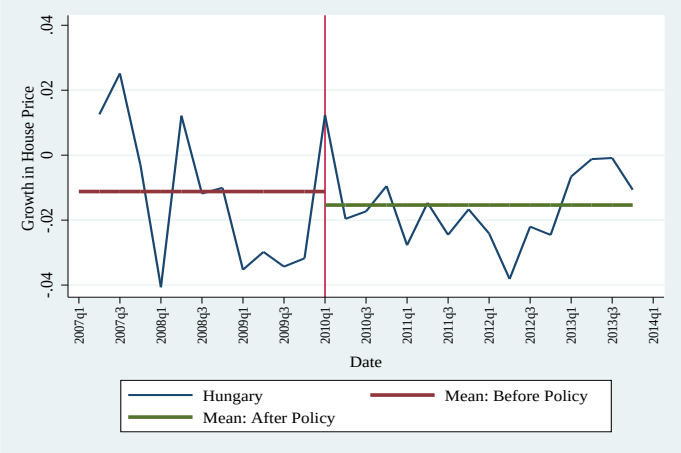


Source: Adapted from CGFS (2012)

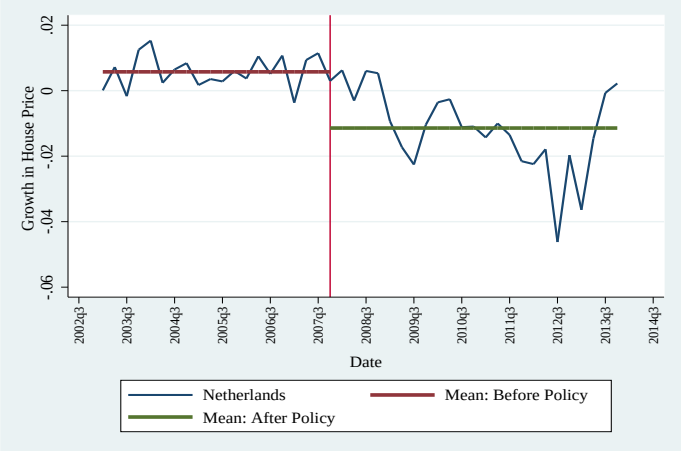
Figure 1.2: The Impact of LTV Ratio Cap on House Prices



(a) **Source: National Statistical Institute**

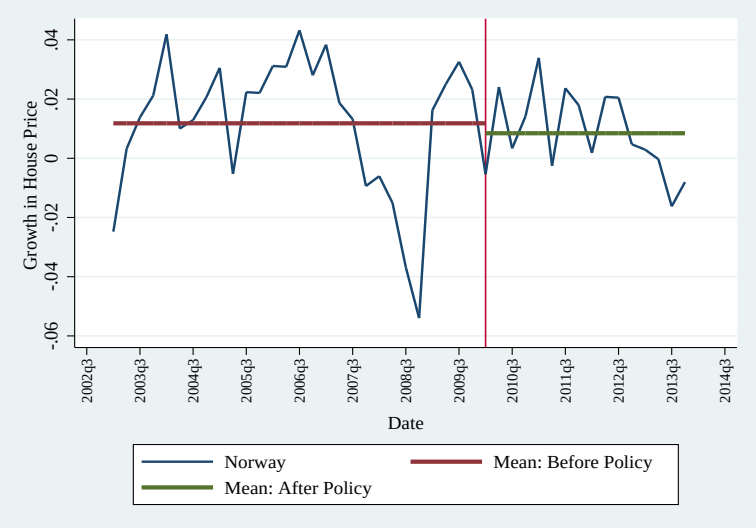


(b) **Source: OECD**

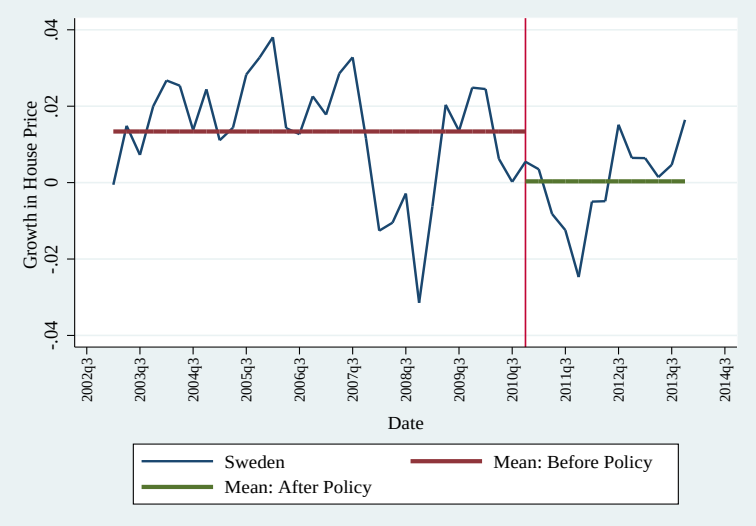


(c) **Source: OECD**

Figure 1.3: (Cont'd.) The Impact of LTV Ratio Cap on House Prices

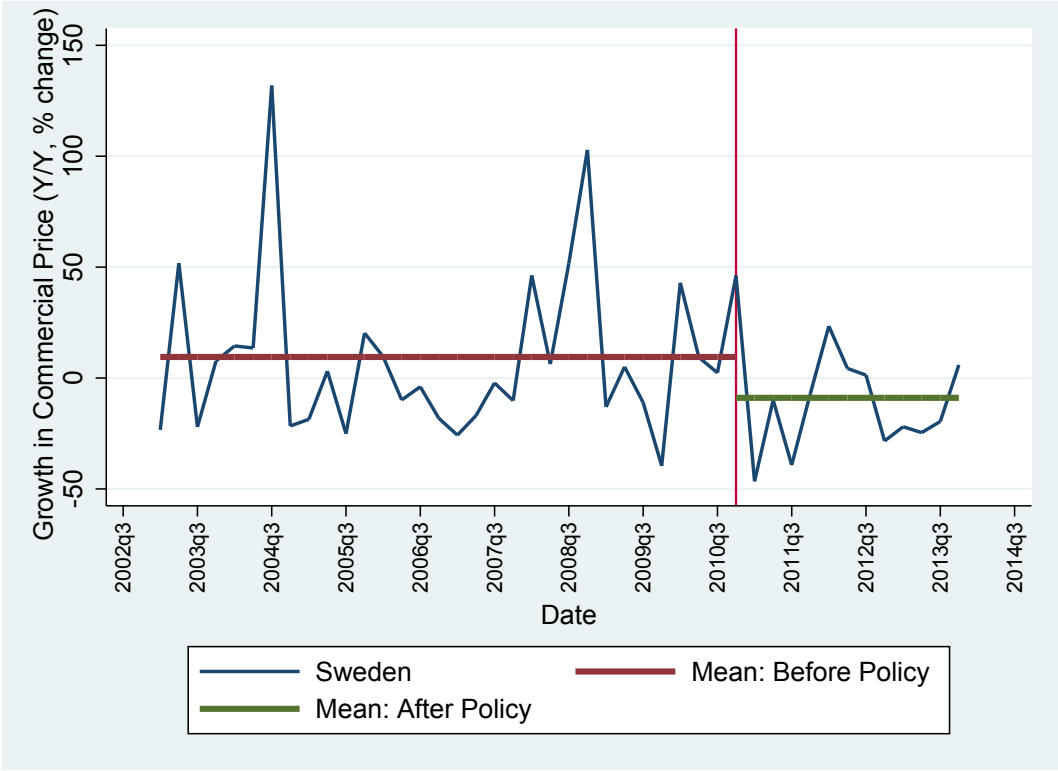


(a) **Source: OECD**



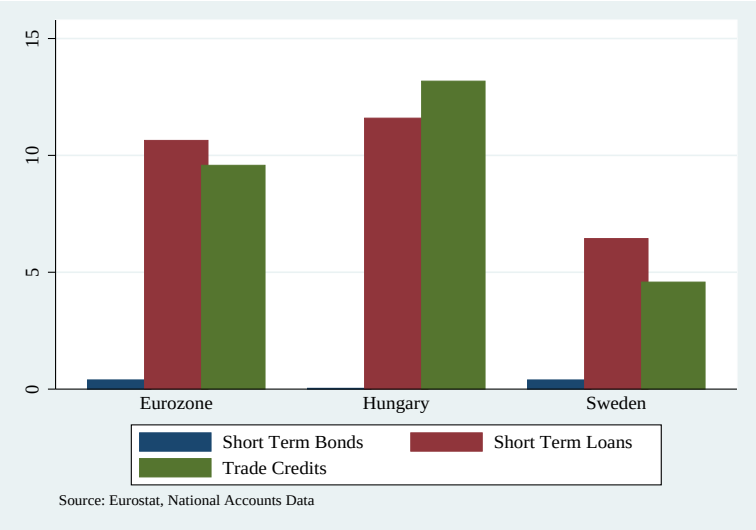
(b) **Source: OECD**

Figure 1.4: The Impact of LTV Ratio Cap on Commercial Real Estate Prices

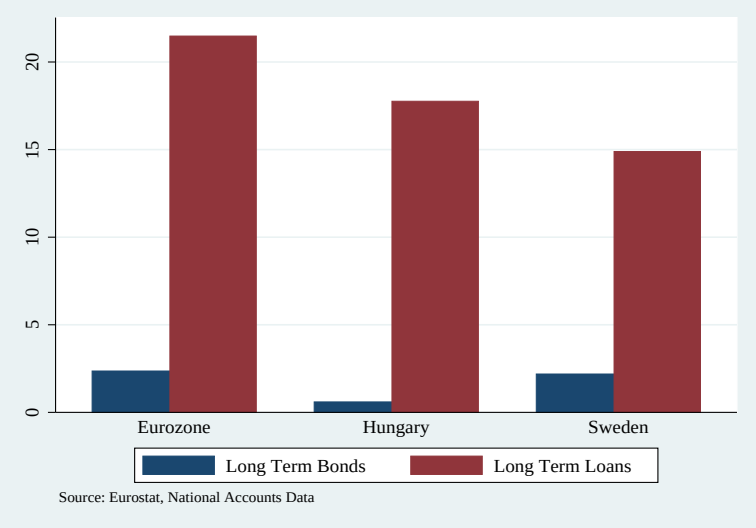


Source: Statistics of Sweden

Figure 1.5: Composition of Firm Liabilities (%): Aggregated Data from Eurostat, 2006

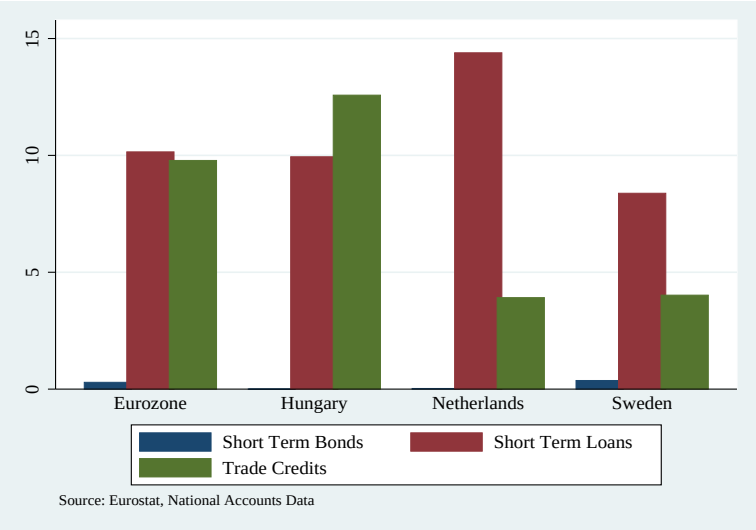


(a) **Short Term Liabilities**

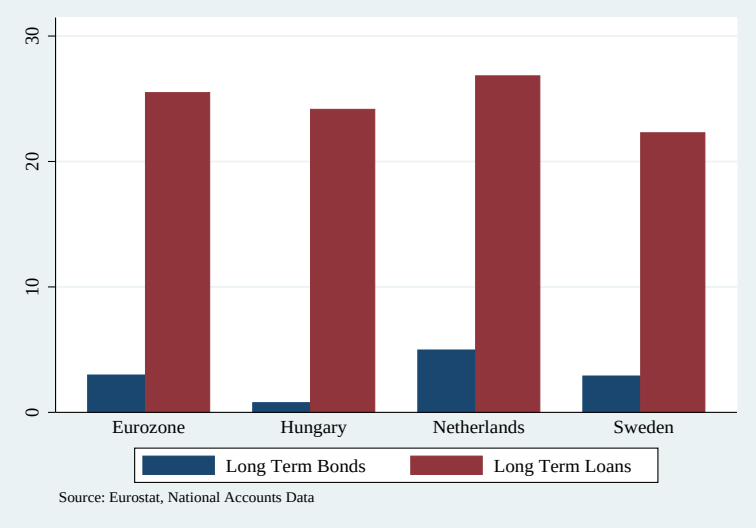


(b) **Long Term Liabilities**

Figure 1.6: Composition of Firm Liabilities (%): Aggregated Data from Eurostat, 2011



(a) **Short Term Liabilities**



(b) **Long Term Liabilities**

Chapter 2

Financial Shocks in Production Chains

2.1 Introduction

Production takes time, especially when conducted through long production chains. The time dimension of production introduces a waiting period between the point when a cost is incurred and when cash flow materializes. Working capital provides the financial resources which fill this gap.

Our main hypothesis is that working capital is the "glue" that binds firms together in a production chain. We address the financial counterparts of the production relationships between firms as suppliers and customers in the production chain. A firm's accounts receivable are claims against customer firms in the production chain—the downstream firms. The flip-side of this relationship is that the downstream firms' accounts *payable* is a liability of the firm backed by its assets, including its own accounts receivable against customers yet further down the chain. Drawing on the insights of Merton (1974), we may think of a firm's accounts payable as defaultable debt backed by its assets.

Accounts receivable and payable generate a chain of interlocking claims and

obligations that bind the interests of the firms within the production chain. Because accounts receivable are very junior claims their value is sensitive to the financial strength of the debtor firm. When the final product generates healthy cash flows, the value of accounts receivable as an asset will be high, to the benefit of all the firms (directly and indirectly) in the production chain. In effect, each firm is a stake-holder in the cash flows generated by the production chain as a whole.

We use a multi-stage generalization of the moral hazard model of Holmstrom and Tirole (1997) to develop three empirical hypotheses, which are then examined using a large data set of firms from OECD countries. The sample covers the recent crisis period, and our focus is on the impact of financial shocks on working capital.

The first hypothesis is that upstream firms (i.e. supplier firms) have higher working capital compared to down-stream firms (final product firms). The reason is that upstream firms are more remote from the direct consequences of their actions. The time to produce and the more numerous intervening firms in the chain entail a higher discount rate on costs and benefits of actions. In order to elicit high effort, the upstream firm's "skin in the game" must be larger relative to revenues than for downstream firms. Net working capital serves as the equity of the firm - its "skin in the game" - in the production chain.

The second, related hypothesis is that upstream firms' working capital is more sensitive to fluctuations in financial conditions than it is for downstream firms. The intuition is that the market interest rate serves as the discount rate that firms use to evaluate the costs and benefits of working capital. When interest rates are high, the direct consequences of shirking become smaller due

to the higher discount rates. Therefore, firms need to hold more equity–more skin in the game–in order to satisfy the incentive compatibility constraint.

There is, however, a sting in the tail, and this leads to our third hypothesis. When the interest rate becomes too high, the viability of the production chain itself becomes problematic, and the chain itself starts to unravel. We therefore predict that the working capital of firms is non-monotonic with respect to the interest rate. For low levels of the interest rate, working capital is increasing in the interest rate, but beyond a threshold point, the working capital declines with the interest rate. This is our third hypothesis.

Our questions bear on the recent paper by Bigio and LaO (2013), who have examined the impact of financial frictions in production networks. Bigio and LaO (2013) model financial frictions by introducing collateral constraints on input purchases. Firms' expenditures on inputs are constrained so that their expenditure is less than a given fraction of their revenue. In a production chain, downstream firms face a tighter constraint, as they must pay for intermediate inputs as well as for labor and direct inputs. In contrast, our model imposes tighter constraints on *upstream firms*. Bigio and LaO (2013) do not pose their hypothesis directly in terms of balance sheet quantities, and so the implications of their model for working capital would need to be developed separately. In this context, one guiding question would be whether downstream firms or upstream firms have higher working capital.

We use firm-level data from ORBIS, a commercial data set provided by Bureau van Dijk (BvD), which contains administrative data on millions of firms worldwide. The accounting information in ORBIS is initially collected by local Chambers of Commerce and in turn, is relayed to BvD through some 40 different

information providers. The data set provides financial and foreign ownership information for each firm, starting in 2000. Our measure of "upstreamness" draws on sectoral interlinkages from input-output matrices developed by Fally (2011), Antràs, Chor, Fally, and Hillberry (2012) and Antràs and Chor (2013).

We find support for all three of our hypotheses. First, upstream firms hold more working capital. Second, upstream firms display higher procyclicality of working capital. As predicted by the model, firms that are higher up in the production chain are more sensitive to fluctuations in the interest rate. Finally, we estimate a quadratic relationship between working capital and the interest rate and find that the estimates are consistent with the non-monotonic relationship suggested by our third hypothesis.

The importance of production chains and complementarities are classic themes in economics, with antecedents in Leontief (1936) and Hirschman (1958). In the same spirit, development economists have studied the technological challenges in sustaining complex production processes. The O-ring theory of Kremer (1993) and the role of intermediate goods and complementarity discussed by Ciccone (2002) and Jones (2011) are examples. As well as these technological constraints, our focus is on the incentive structure of production chains. One motivating example is the breakdown of production chains in the post-Soviet economies in the 1990s. Blanchard and Kremer (1997) and Marin and Schnitzer (2005) attribute the drastic fall in output to hold-up problems and the recursive nature of the rent-seeking along the production chain that undermined pre-existing production chains of the Soviet-era command economy.

The mutual stakes held by firms in the production chain differ in important ways from the cross-holding of shares. First, accounts receivable mirror exactly

the production relationships within the chain. Cross-shareholding is a blunter device that lag the shifts in the underlying production relationships. Second, and more important, accounts receivable are held by *upstream* firms (often, small and medium sized firms) against their *downstream* counterparts (final goods manufacturers). This is in the opposite direction from the archetypal picture of the large, final goods firm holding equity stakes in its smaller suppliers in a vertically integrated production structure.

Our framework sheds light on a puzzle raised in the trade credit literature—namely, why firms persist in maintaining large stocks of accounts payable, even though some industries have substantial discounts for prompt cash settlement (see the survey evidence in Ng, Smith, and Smith (1999). A common invoicing practice among U.S. firms is the so-called "2-10 net 30" contract, meaning that if the invoice is settled within ten days, there is a discount of 2%, and otherwise the invoice must be paid within 30 days (without discount). The implied annual interest rate for the additional 20 days of credit comes out is over 40% and, everything else equal, it is hard to comprehend why a firm would borrow at such a high rate of interest.

The statistics we obtain from Business Environment and Enterprise Performance Survey of the World Bank provide additional evidence on the payment terms of European firms.[1] Those statistics in Table 2.2 suggest that most of

[1]World Bank compiles the corresponding establishment-level data by conducting mostly face-to-face interviews, which are administered in roughly parallel fashion to enterprises in selected European countries. The data set provides a basis for making country comparisons of investment climate conditions, as well as comparisons of the severity of constraints affecting firms and performing country-specific evaluations. It captures firm perceptions of key constraints in the business environment, perceptions that shape operational and investment decisions, as well as several quantitative indices of firm experience. For further details, see Kalemli-Ozcan and Sørensen (2014).

European firms prefer postponing their payments. To illustrate, 65 % of German firms answered that none of their sales to customers in value terms over the last 12 months were paid before the delivery of their products or services.[2] In the same manner, only 1 % of German firms answered that all of their sales to customers in value terms over the last 12 months were paid before the delivery of their products or services.

However, within our framework, a firm may have an incentive to maintain accounts payable if early redemption raises the probability of failure for the chain by lessening the incentives of upstream firms. If upstream firms (suppliers) paid in advance then they might have a lower incentive in keeping the production chain going. [3] We will show that the upstream firm has positive net receivables so he is a net creditor.

Working capital is more familiar to the literature on financial crises, especially those in emerging economies. Calvo, Izquierdo, and Talvi (2006) document several stylized facts which appear consistently during financial crises, for example that credit and total factor productivity drop sharply with the onset of the crisis but that employment drops to a lesser extent. Our model addresses these features, and our deliberately stark modeling choices enable a relatively clean identification of the working capital channel of financial shocks.

[2]The question is as follows: "What percentage of your firm's sales' to customers in value terms over the last 12 months were **(a)** paid before the delivery of your products or services/**(b)** paid on delivery of your products or services/**(c)** sold on credit (payment due after the time of delivery of your products or services)?"

[3]Blanchard and Kremer (1997)'s concept of disorganization can be understood in terms of our framework as the case where a complex production economy makes a sudden transition from one that is under central direction to a decentralized network of firms. The transition takes place without the benefit of large interlocking balance sheets. The result is a breakdown of incentives, undermining the complex production chain.

Neumeyer and Perri (2005) and Mendoza (2006) have emphasized working capital shortages in their models of fluctuations in emerging economics. although their modeling relies on quantitative constraints on firms' financing. Raddatz (2006, 2010) presents cross-section evidence using firm level data that financial shocks affect firm level financing needs as revealed through components of working capital.

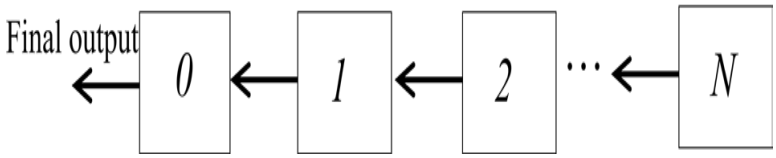
This chapter contributes to an active debate on how macroeconomic activity is affected by fluctuations in the interest rate faced by corporate borrowers. Gilchrist, Yankov, and Zakrajšek (2009) and Gilchrist and Zakrajsek (2012) document that credit spreads have substantial effect on macro activity measures. The contribution of this chapter is to highlight the working capital channel of financial frictions, and show how financing cost can impact output even in a model without physical capital or labor/product market distortions.

This chapter proceeds as follows. Section 2.2 introduces basics of the theoretical model. Section 2.3 details the construction of upstreamness measure. Section 2.4 explains the details of the data used in this chapter. Section 2.5 shows how we test the implications of our model as well as the results. Section 2.6 concludes.

2.2 Model

Our model builds on Kim and Shin (2012), which in turn is a multi-stage version of Holmstrom and Tirole (1997) model of moral hazard. The model is built around a production chain as depicted in Figure 2.1. Firm 0 sells the final output. The other firms produce intermediate inputs that are necessary in the

Figure 2.1: Production Chain



production of the final good. Firm $i+1$ supplies its output to firm i. In addition to firm 0, there are N upstream firms.

There is a "time to build" element in the production. Each step of the production process takes precisely one period of time, where time is indexed by $t \in \{0, 1, 2, \cdots\}$. Firm i incurs a production cost of w_i, which must draw on the firm's cash holdings, and cannot be deferred. We may interpret w_i as the wage costs of firm i, and so this feature corresponds to the assumption that firms cannot borrow from workers.

Each firm has the choice of high effort or low effort. If all firms exert high effort, then the output of the production chain can be sold at price $q_N > 0$ with certainty. However, if one or more firms exert low effort, there is a probability $\varepsilon > 0$ that the product fails, and the production chain must be dismantled. Low

Table 2.1: Cash flows before transfers

		Firms				
		0	1	$\cdots$	$N-1$	N
date t	0					$-w_N$
	1				$-w_{N-1}$	$-w_N$
	$\vdots$			$\cdots$	$-w_{N-1}$	$-w_N$
	$N-1$		$-w_1$	$\cdots$	$-w_{N-1}$	$-w_N$
	N	$-w_0$	$-w_1$	$\cdots$	$-w_{N-1}$	$-w_N$
	$N+1$	$q_N - w_0$	$-w_1$	$\cdots$	$-w_{N-1}$	$-w_N$
	$N+2$	$q_N - w_0$	$-w_1$	$\cdots$	$-w_{N-1}$	$-w_N$
	$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$

effort by firm i can be interpreted as the decision to economize on the cost of producing firm i's intermediate good, and to divert the resulting cost saving to alternative uses that result in private benefit, but is detrimental to the success of the final output in the spirit of Holmstrom and Tirole (1997).

Conditional on the product not failing, the cash flows of the firms (before any transfers take place) can be depicted as in Table 2.1. Once the final product begins to generate a cash flow, the revenue cascades back up the production chain instantaneously. Denote by p_i the per-period payment to firm i from firm $i-1$ for the intermediate good. In turn, firm i pays p_{i+1} to its own supplier, firm $i+1$. All firms face the interest rate r, which reflects the cost of credit to the firm. The firm discounts future payoffs at interest rate r. By exerting low effort, firm i enjoys per-period private benefit of

$$bw_i \tag{2.1}$$

where $b > 0$ is common to all firms. If firm i exerts low effort today, the probability of product failure is ε when the final good goes on sale $i+1$ periods ahead. When firm i has exerted high effort at every date in the past, the expected payoff from exerting high effort at all subsequent dates is

$$(p_i - p_{i+1} - w_i) \sum_{\tau=0}^{\infty} \frac{1}{(1+r)^{\tau}} \tag{2.2}$$

The payoff to deviating to low effort today for one period is

$$bw_i + (p_i - p_{i+1} - w_i) \left(\sum_{\tau=0}^{i} \frac{1}{(1+r)^{\tau}} + (1-\varepsilon) \sum_{\tau=i+1}^{\infty} \frac{1}{(1+r)^{\tau}} \right) \tag{2.3}$$

So, the incentive compatibility constraint against a one period deviation to low effort is

$$p_i \geq p_{i+1} + (1+b_i)\, w_i \tag{2.4}$$

where b_i is the positive constant

$$b_i = \frac{b \cdot r\,(1+r)^i}{\varepsilon} \tag{2.5}$$

As well as the one period deviation, the firm has other possible deviations but it can be shown that the incentive compatibility constraint (2.4) is sufficient to rule out all other possible deviations from high effort (see Kim and Shin (2012)).

The constraint (2.4) captures the *recursive moral hazard* inherent in our model. The moral hazard is recursive in the sense that the payment to firm i must be sufficiently large so as to induce it not to take the private benefit, but the payment to firm i also includes the rent that is due to its supplier firm, $i+1$. In turn, the payment p_{i+1} includes rents that accrue to suppliers further up the chain.[4] The payments $\{p_i\}$ that make the incentive compatibility constraints

[4]Saki Bigio has pointed out that the value function V_i for firm i in the planner's problem can be defined recursively as $V_i = \max\left\{\frac{V_{i-1}+V_i}{1+r}, \frac{1-\varepsilon}{1+r}(V_{i-1}+V_i) + bw_i\right\} - w_i$. Then $V_i < V_{i-1}$, so that upstream firms have lower value and are more prone to moral hazard.

bind are given by

$$p_i = \sum_{k=i}^{N} (1 + b_k)\, w_k \tag{2.6}$$

The prices $\{p_i\}$ incorporate rents $\{b_k w_k\}$ for all the upstream firms k along the production chain. Production of the final good is feasible only when $q_N \geq \sum_{k=0}^{N} (1 + b_k)\, w_k$. Equation (2.6) points to the possibility that long production chains may break down, not only because of the technological/logistical concerns[5] but also because of the viability of production in the face of incentive problems. However, interlocking balance sheets through accounts receivable can improve the allocation, at the expense of requiring greater working capital for the firms. Suppose that firm i maintains accounts receivable R_i from firm $i-1$, and maintains accounts payable of P_i to firm $i+1$. The accounts receivable and accounts payable are inter-firm credit, and they are amortized as perpetuities. Thus, R_i is amortized with constant payment $a_i p_i$. The per-period payment from $i-1$ to i gross of the underlying sale price is:

$$(1 + a_i)\, p_i \tag{2.7}$$

In the presence of amortization payments, the incentive compatibility constraint with working capital is given by:

$$(1 + a_i)\, p_i \geq (1 + a_{i+1})\, p_{i+1} + (1 + b_i)\, w_i \tag{2.8}$$

When the incentive compatibility constraints bind, the payments $\{p_i\}$ along the chain satisfy:

[5]The fragility of long production chains has received much attention from development economists (see Kremer (1993) and Jones (2011))

$$p_i = \frac{1}{(1+a_i)} \sum_{k=i}^{N} (1+b_k)\, w_k \tag{2.9}$$

By holding a sufficiently large account receivable R_i, the amortization payment can be made large, and so the fundamental price p_i can be made as low as desired. We search for a solution to the optimal contracting problem where the underlying price p_i satisfies the participation constraint; the discounted sum of wage costs. In other words, the underlying fundamental prices satisfy

$$p_i = \sum_{k=i}^{N} (1+r)^{k-i+1}\, w_k \tag{2.10}$$

The incentive compatibility constraint binds in the optimal contract, so that from (2.8) and (2.10) we have

$$\begin{aligned} a_i p_i - a_{i+1} p_{i+1} &= p_{i+1} - p_i + (1+b_i)\, w_i \\ &= -(1+r)\, w_i - r p_{i+1} + (1+b_i)\, w_i \\ &= \left(b_i - r\frac{p_{i+1}}{w_i} - r \right) w_i \end{aligned} \tag{2.11}$$

Substituting (2.5) into (2.11) we have

$$a_i p_i - a_{i+1} p_{i+1} = \left(\frac{b\,(1+r)^i}{\varepsilon} - \frac{p_{i+1}}{w_i} - 1 \right) r w_i \tag{2.12}$$

Equation (2.12) gives the net interest payment received by firm i. For ε small enough, the net interest payment is positive, reflecting the fact that the firm is a net lender along the chain, which is to say that its *net receivables* are

positive. Note that $R_i = \sum_{\tau=1}^{\infty} \frac{a_i p_i}{(1+r)^\tau} = \frac{a_i p_i}{r}$ and $P_i = \sum_{\tau=1}^{\infty} \frac{a_{i+1} p_{i+1}}{(1+r)^\tau} = \frac{a_{i+1} p_{i+1}}{r}$. So we have

$$R_i - P_i = \left(\frac{b\,(1+r)^i}{\varepsilon} - \frac{p_{i+1}}{w_i} - 1 \right) w_i \tag{2.13}$$

The first term inside the parenthesis of equation (2.13) is increasing in i and the second term is decreasing in i, which implies that $R_i - P_i$ is increasing in i. We thus have the following result.

Proposition 1. *The net receivables of firm i relative to w_i is higher for upstream firms.*

In other words, the working capital of upstream firms is higher than the working capital of downstream firms. The incentive compatibility constraints bind harder for upstream firms compared to downstream firms. Note from (2.13) that for ε small enough the net receivables of any firm is increasing in the interest rate r, provided that the production chain remains viable in the sense that $q_N \geq p_0 = \frac{1}{(1+a_0)} \sum_{k=0}^{N} (1+b_k)\, w_k$. However, since $\{b_k\}$ are increasing in r, when r reaches a threshold level r^* that is high enough (to ensure $q_N = \frac{1}{(1+a_0)} \sum_{k=0}^{N} \left(1 + \frac{b \cdot r^* (1+r^*)^i}{\varepsilon}\right) w_k$), the production chain is no longer economically viable and breaks down. The most upstream firm N then falls out of the chain and produces as a stand-alone firm. We thus have the following proposition, which gives our main empirical hypothesis.

Proposition 2. *The net working capital of firm i is non-monotonic in interest rate r. For small increases, net working capital increases. However, if $r > r^*$ for some threshold r^*, firm i's net working capital falls.*

A clear empirical prediction is that firms that are higher up the chain are more sensitive to the fluctuations in the interest rate. When credit conditions

are permissive, so that r falls, then longer production chains become viable, so that more firms enter the production chain as upstream firms. However, when the interest rate rises during crises, the production chain shortens and upstream firms exit from the chain.

2.3 Measuring Sector-Level Upstreamness

2.3.1 Conceptual Measures of Upstreamness

We construct an industry-level measure of firms' typical location in the production chain based on Antràs, Chor, Fally, and Hillberry (2012) and Fally (2011).[6] We first outline the main features of these measures and then give further details on how we calculate our measures. Fally (2011) proposes a measure which proxies the distance from final-good production. The intuitive logic of this measure is that industries selling a disproportionate share of their output to relatively upstream industries should be relatively upstream themselves.

The measure is defined as:

$$U_i = 1 + \sum_{j=1}^{N} \frac{d_{ij} Y_j}{Y_i} U_j \tag{2.14}$$

where $d_{ij}Y_j/Y_i$ is the share of sector i's total output that is purchased by industry j. It is clear that $U_i \geq 1$. The corresponding upstreamness values for each industry are placed in the matrix U, which is equal to $[I - \Delta]^{-1}\mathbf{1}$ where Δ is the matrix with $d_{ij}Y_j/Y_i$ in entry (i,j) and $\mathbf{1}$ is column vector of ones.

[6] There are other studies that develop measures of upstreamness: Bigio and LaO (2013) employs for U.S. firms an industry-level measure of upstreamness constructed using Input-Output (I-O) tables compiled by the Bureau of Economic Analysis. Gofman (2013) constructs a firm-level measure of upstreamness using a novel database that provides information on supplier-customer relationships for 990 U.S. firms.

2.3.1.1 Economic Interpretation of Measures of Upstreamness

Antràs, Chor, Fally, and Hillberry (2012) show that this measure (and the equivalent measure suggested by Antràs and Chor (2013)) have the following interpretations: a) Holding constant the final-use vector F and off diagonal elements of the matrix D, we have the following expression:

$$U_i = \frac{1}{Y_i} \sum_{j=1}^{N} \frac{\partial Y_i}{\partial d_{jj}} \tag{2.15}$$

so U_i equals the semi-elasticity of an industry's output to a uniform change in input-output linkages within industries. Intuitively, when the extent to which industries rely on inputs from their own sector increases, this will tend to increase output in all industries, but one would expect the effect to be disproportionately larger in upstream industries via a multiplier effect. and b) Holding constant allocation matrix Δ, we have the following expression:

$$U_i = \sum_{j=1}^{N} \frac{\partial Y_i}{\partial V_i} \tag{2.16}$$

where V_i refers to value added in industry i. Thus, U_i turns out to equal the dollar amount by which output of all sectors increases following a one dollar increase in value added in sector i.

2.3.2 Upstreamness in an Open Economy

In an open economy context, (13) is modified to the following expression:

$$Y_i = F_i + Z_i = F_i + \sum_{j=1}^{N} d_{ij} Y_j + X_i - M_i \tag{2.17}$$

The share of a country's gross output in industry i that is used as intermediate input in industry j (at home or abroad) is given by the ratio:

$$\delta_{ij} = \frac{d_{ij}Y_j + X_{ij} - M_{ij}}{Y_i} \tag{2.18}$$

where the following assumption i.e. $\delta_{ij} = X_{ij}/X_i = M_{ij}/M_i$ is imposed. Because in practice, information on international interindustry flows i.e. X_{ij} and M_{ij} is missing. Thus, d_{ij} is modified to:

$$\widehat{d_{ij}} = d_{ij}\frac{Y_i}{Y_i - X_i + M_i} \tag{2.19}$$

It can be easily verified that two measures of upstreamness given in Equation 2.15 and Equation 2.16 stay equal after replacing d_{ij} with $\widehat{d_{ij}}$.

2.3.3 How to Measure Upstreamness in OECD Countries?

We use the OECD STAN database, which provides input-output (I-O) tables for many countries. Following Antràs, Chor, Fally, and Hillberry (2012), we focus on the 16 OECD countries that, as of 2005, reported data using the same industry classification, namely, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Italy, Netherlands, Portugal, Slovakia, Slovenia, Spain, and the United States.[7] The countries have common industry classifications for 41 sub-industries, 18 of which are in manufacturing.[8] Thus, we focus on 18 sub-industries of manufacturing that share an exact

[7]Different from Antràs, Chor, Fally, and Hillberry (2012), Luxembourg is excluded from our analysis. See the following data section for details about sample selection criteria.

[8]We have to exclude the sectors that are not reported in Eurostat from our analysis. We assume that those sectors have been merged into other sectors by Eurostat. The excluded sectors are: "pharmaceuticals," "non-ferrous metals," "railroad equipment and transport equipment," "aircraft and spacecraft," "manufacture of gas," "steam and hot water supply," and "household and social work."

aggregation of the data for 2005.

We use the detailed Supplementary Use Tables after redefinitions whose $(i,j)^{th}$ entry reports the value of inputs of commodity i used in the production of industry j in the given country's economy. Taking the open-economy adjustment in (21) into account, we construct the related square matrix Δ for each individual country in the OECD sample. The numerator of the $(i,j)^{th}$ entry of Δ; i.e., $d_{ij}Y_j$ is precisely the value of commodity i used in j's production. We therefore plug in the $(i,j)^{th}$ entry from the Use Table for this numerator. The denominator $Y_i - X_i + M_i$ is in turn calculated as the sum of values in row i of the Use Table, less that recorded under net exports and net changes in inventories. With this Δ, the formula $[I-\Delta]^{-1}\mathbf{1}$ then delivers a column vector whose i^{th} entry is the upstreamness value for industry i of the given country.

Using the above-mentioned methodology, we calculate the upstreamness values for each given country-industry pair in our OECD sample.[9] We first check the joint correlation of upstreamness values across all countries in our OECD sample through a principal component analysis. We find that 79 percent of the cross-country variation in upstreamness values is captured by a single component suggesting that upstreamness values are jointly correlated to a high degree.

Table 2.3 displays the mean upstreamness values by sub-industries of manufacturing industry. Each individual mean upstreamness value is obtained by averaging the corresponding upstreamness values of the given sub-industry over all

[9]We replicate Table 3 in Antràs, Chor, Fally, and Hillberry (2012) to verify the consistency of industry upstreamness values across our countries. Similarly, we conduct a Spearman rank correlation test among all countries in our OECD sample. For each individual country, the rank correlation is large and positive, which is significantly different from zero with p-value of 0.01. Those correlations can be requested from the authors.

countries in our OECD sample.[10] Those mean values reveal that sub-industries of manufacturing industry vary considerably in terms of their average production line position. The mean upstreamness value across those 18 sub-industries ranges from a minimum of 1.84 (Food products, beverages and tobacco) to a maximum of 3.97 (Iron and steel). That is, on average, "food products, beverages and tobacco" is the the most downstream industry with most of its output going directly to the end-user, while "iron and steel" is most upstream industry operating to manufacture raw materials. Across those sub-industries, we find a mean upstreamness of 2.53, and a standard deviation of 0.56. The average sub-industry in manufacturing industry therefore enters into use in production processes roughly more than two stages before final consumption or investment.

2.4 Measuring Firm-Level Accounts

Our analysis exploits cross-country firm-level data from ORBIS, focusing on OECD countries. ORBIS is a commercial dataset provided by BvD, which contains administrative data on millions of firms worldwide. The financial and balance sheet information is initially collected by local Chambers of Commerce and in turn, is relayed to BvD through some 40 different information providers. For European countries the data goes back to 1996 but for most countries most reliable data starts in 2000 (for U.S. in 2005). Further details about our data and preliminary data cleaning are available in Kalemli-Ozcan, Sorensen, and Yesiltas (2012) and Kalemli-Ozcan, Sorensen, and Volosovych (2014).

The data set provides financial and ownership information for each firm. We

[10]The upstreamness values we calculate for each individual country-industry pair are available from the authors.

use an unbalanced panel of firms and ascertain that the panel does not suffer from survivorship bias by assembling our data from historical, archived releases of the database.

2.4.1 Sample Selection Criteria

Focusing only on the manufacturing firms from our 16 OECD countries, we have medium/large/very large firms from different sub-industries, which are classified according to two-digit NACE Revision 1.1. Primary codes.[11] We apply the following sample selection criteria to obtain our final sample:

- We drop firms that have inconsistent information on any generic variables such date of establishment/type of company/template etc.
- We drop firm-year observations with negative values of all types of assets/liabilities.
- We drop firm-year observations with negative values on employment, sales and operating revenue.
- We keep the firms with non-missing information on key variables such as accounts payable, accounts receivable, working capital and operating revenue between 2000–2009.
- We first trim both 1% tails of distribution of "accounts payable to operating revenue," "accounts receivable to operating revenue," "net accounts receivable to operating revenue," and "working capital to operating revenue."

[11] BvD defines medium, large and very large firms as firms with employees more than 15, 150, and 1000, respectively.

- In the cross-section regressions where we use growth values of "working capital over operating revenue" as dependent variables, we also drop the firm-year observations of the respective dependent variables whose z-scores are greater than 5 in absolute value.[12]

After this, we continue our analysis with countries having at least 1000 observations between 2000 and 2009 and we exclude Luxembourg. Of note, U.S. firms have limited data for 2000–2003, thus we only use the period 2004–2009 for the United States throughout the empirical analysis.

Table 2.4 displays the list of countries in our sample. We have over 150 thousand manufacturing firms (over 600 thousand firm-year observations). Table 2.5 presents the number of observations by firm types: medium/large/very large, listed/unlisted, and young/mature. Our sample is heterogeneous in terms of firm type as most of our firms are medium unlisted mature manufacturing firms.[13]

2.4.2 Definitions of Firm-level Variables

The key financial variables we use are accounts receivable, accounts payable, stocks (inventories), working capital, operating revenue, total assets, short-term

[12] We construct the z-scores as $|\frac{x_{it}-m}{sd}|$ where x, m, and sd refer to the value, mean, and standard deviation of the corresponding growth variable.

[13] ORBIS is not fully representative because smaller and younger firms are under-represented and more so in some countries than in others. Various methods have been used in the literature to address this issue. For example, Andrews and Cingano (2014) align the sample of firms with the distribution of firm populations as reflected in the OECD Structural Demographic Business Statistics (SDBS), which is based on confidential national business registers. They use re-sampling weights, based on the number of employees in each SDBS industry-size class cell, which essentially scales-up the number of observations in each cell so that they match those observed in the SDBS. Kalemli-Ozcan, Sorensen, and Volosovych (2014) do another adjustment using propensity score matching on the data used in this chapter and observe no differences in the results between the full data set and the data set constructed to be representative across countries.

debt, bank debt, long-term debt, and total debt. We use Total Assets (TA) and Operating Revenue (OR) to normalize the financial variables that we use in our empirical analysis.[14] Our theoretical model uses inter-firm credit figures relative to production cost. We used such figures (accounts receivable, accounts payable, working capital) relative to wage bill, total input cost and also operating revenue obtaining similar results. Since normalizing inter-firm claims by operating revenue maximizes number of observations we opt for that.

Accounts Receivable (REC): Total book value of trade receivables (credit extended to customers).

Accounts Payable (PAY): Total book value of trade debt to suppliers.

Net Accounts Receivable (N_REC): It is calculated as "Accounts Receivable minus Accounts Payable."

Stocks: Total book value of total inventories (raw materials+ plus goods in progress plus finished goods).

Working Capital (WC): Stocks plus Accounts Receivable minus Accounts Payable. Other short term assets such as other current assets, prepaid expenses, deferred Charges and other current liabilities such as other short term debt, other creditors are not included.

Short-term Debt: Total book value of short-term financial debt to credit institutions, and all debt to trade creditors.

Bank Debt: Total book value of short-term and long-term financial debt to banks.

Total Debt: Total book value of short-term and long-term financial debt to

[14]We convert all financial data into "2005 PPP dollars" using yearly GDP deflators with 2005 base from the World Bank and 2005 end-of-year US dollar exchange rates.

credit institutions.

Operating Revenue (OR): Total operating revenue (Net Sales plus Other Operating Revenues plus Stock Variations). The figures do not include VAT, excise taxes, or similar obligatory payments.

Total Assets (TA): Total book value of tangible and intangible fixed assets.

2.5 Empirical Analysis

2.5.1 Financing Choice of Firms: Inter-firm Financing Patterns

Table 2.6 provides the descriptive statistics of pooled OECD sample. All financial variables are normalized by Total Assets (TA) to be comparable. We further normalize accounts payable, accounts receivable, net accounts receivable, and working capital also by Operating Revenue (OR) because this is how they are used in the regression analysis and present those numbers in the last four rows of Table 5. The mean values of the financial ratios suggest that inter-firm financial contracting are important financing choices of the manufacturing firms in the OECD sample. On average, trade credit and provisions constitute a large part of their balance sheet. Accounts payable and accounts receivable (23% and 33% of total assets, respectively) are comparable to the level of short-term debt and total debt (36% and 46% of total assets, respectively). In fact, for the manufacturing firms in the OECD sample, on average the level of accounts payable is higher than the size of external finance from banks as total bank debt constitutes 22% of total assets.[15]

[15]The mean values are consistent with those presented in the pioneering study of Rajan and Zingales (1995). In their paper, they study the balance sheets of non-financial firms in the G7 countries, of which 3 are included in our analysis. They find that the level of accounts

The above statistics suggest that trade credit usage and provision levels are important. Can this pattern be explained by firms lacking access to external finance? To answer this question, we check trade credit usage and provision levels of potentially financially constrained/unconstrained firms in our sample. We follow the financing constraints literature which suggests that mature, large, and/or listed firms are the least likely to be constrained.[16] Given this stylized fact, we group the manufacturing firms in our OECD sample according to their size, age, and legal status.

Tables 2.7–2.8 display the descriptive statistics of accounts receivable and accounts payable for different firm types. As reported, medium, young and unlisted manufacturing firms, which are more likely to be financially constrained, provide trade credit to their customers (mean ratios of accounts receivable to total assets are 0.34, 0.33, and 0.35, respectively) while they borrow from their suppliers (mean ratios of accounts payable to total assets are 0.24, 0.23, 0.28, respectively.) In the same manner, very large, mature and listed manufacturing firms, which are more likely to be financially unconstrained use trade credit (mean ratios of accounts payable to total assets are 0.14, 0.09, and 0.22, respectively) whereas they lend to their customers (mean ratios of accounts receivable to total assets are 0.21, 0.16, and 0.32, respectively).[17] These patterns therefore imply simultaneous usage and provision of trade credit at a level which is

receivable and accounts payable in United States, Germany and Italy (17.8%, 26.9%, 29%; 15%, 11.5%, 14.7% of total assets, respectively) are comparable to the level of total liabilities (66.1%, 72%, 67.4% of total assets, respectively)

[16] See Hubbard (1998), and Bond and Van Reenen (2007) for comprehensive surveys.

[17] We implement independent group t-tests within each group to compare the mean values of the financial ratios across the respective two types. In each t-test, we have quite high t-statistics, which in turn suggests that the difference in means is statistically significantly different from zero at 1% level.

not simply a reflection of lacking bank credit. We further check the correlation between accounts receivable and accounts payable and find a correlation between accounts payable (normalized by total assets) and accounts receivable (normalized by total assets) of 53%, statistically significant at the 1% level. This indicates that manufacturing firms in our OECD sample simultaneously borrow from their suppliers and lend to their customers.[18]

2.5.2 Testing Proposition 1

The magnitude of the moral hazard problem varies with the vertical position of the firm in the supply chain. Firms at a higher position in the supply chain are less sensitive to the success of final product, because their cost of low effort is going to be realized at a later stage while the private benefit is realized instantaneously. The optimal level of incentives therefore increases with the vertical position of the firms in the supply chain as stated in Proposition 1. We test this proposition by examining the relation between upstreamness and accounts payable (PAY), accounts receivables (REC), net accounts receivable (N_REC), and working capital (WC)—all normalized by operating revenue (OR). The prediction of Proposition 1 is that the latter two variables are positively correlated with upstreamness. We estimate the following equation:

$$F_{i,s,t,c} = \beta_0 + \beta_1 \text{UPS}_{s,c} + \mu_c + \mu_t + \varepsilon_{i,s,t,c} \ , \tag{2.20}$$

where $F_{i,s,t,c}$ is one of four firm-level financial variables examined. $\text{UPS}_{s,c}$ refers to upstreamness value that proxies the vertical position of firms in the supply

[18] Gofman (2013) conducts the same type of analysis using a subset of U.S. non-financial firms and finds patterns of trade credit consistent with our model.

chain. The measure is constructed for each individual industry-country pair, but only available in 2005. A positive β_1 implies that firms with higher upstream values have higher values of the financial variables F, on the left-hand side. μ_c and μ_t represent country and year dummies (fixed effects), respectively. The parameter of interest is the OLS coefficient β_1, in particular, a test of $\beta_1 = 0$ for the cases of net accounts receivable and working capital is a test of Proposition 1.

Table 2.9 displays OLS panel regression results for the estimation of Equation 2.20. We find that the relationship between upstreamness and accounts payable is positive and highly significant and even larger and highly significant for accounts receivable. Because the latter correlation is higher the correlation between upstreamness and net accounts payable is also positive with very strong statistical significance as indicated by the t-statistic of 31.65. As net accounts receivable is a component of working capital, Proposition 1 implies that the relationship between working capital and upstreamness should be positive and the fourth column verifies this hypothesis, again with a t-statistic over 30.

2.5.3 Testing Proposition 2

The moral hazard problem as articulated in our model is that firms in the production chain may choose to exert low effort to economize on their production cost and use the resulting savings in alternative ways that bring them private benefit. When discount rates are high, firms bear less of the direct consequences of their actions, and so the incentive compatibility constraint implies a higher "skin in the game" when interest rates are high. Provided that the production chain remains viable, as interest rates increase, higher incentives are needed to overcome moral hazard problem. However, when interest rates becomes high

enough, the chain start breaking down and the most upstream firms fall out. The relationship between needed incentives are there non-monotonic, as stated in Proposition 2. We test this prediction by estimating the following equation:

$$F_{i,s,t,c} = \beta_0 + \beta_1(\text{UPS}_{s,c} \times \text{spread}_t) + \beta_2(\text{UPS}_{s,c} \times \text{spread}_t^2) + \mu_c + \mu_s + \mu_t + \varepsilon_{i,t} \ . \tag{2.21}$$

The variables are as previously defined, except we add Spread_t which refers to the Bank of America (BofA) Merrill Lynch US Corporate AA Option-Adjusted Spread in a given year.[19] Annual spread values used in our estimation are constructed by collapsing daily time series into annual time series. Spread^2 is the square of the spread. The interaction variables are constructed by the multiplication of (spread-$\overline{\text{spread}}$), (UPS-$\overline{\text{UPS}}$) and (spread^2-$\overline{\text{spread}^2}$), (UPS-$\overline{\text{UPS}}$); respectively, where $\overline{\text{X}}$ is the mean of any generic variable X. μ_c, μ_s, and μ_t represent country, sector and year dummies (fixed effects), respectively. The level (direct) effects of spread and spread squared are absorbed by the time dummies.

The parameters of interest are the OLS coefficients β_1 and β_2: a positive β_1 implies that upstreamness displays a positive correlation with the spread while a negative β_2 implies that the relation is non-monotonic in the spread. Table 2.10 displays the results: for both accounts receivable and accounts payable, we find with high statistically significance that the impact of small interest

[19]The Option-Adjusted Spread (OAS) of the BofA Merrill Lynch US Corporate AA Index is a subset of the BofA Merrill Lynch US Corporate Master Index that tracks the performance of U.S. dollar denominated investment grade rated corporate debt publicly issued in the U.S. domestic market. This subset includes all securities with a given investment grade rating AA. The BofA Merrill Lynch OAS is the spread between a computed OAS index of all bonds in a given rating category and a spot Treasury rate.

rate spreads is relatively stronger for upstream firms—with accounts receivable displaying a larger effect implying, as seen in the third column, that net receivables are stronger affected by the spread in upstream firms. Further, the negative (significantly) estimated β_2 coefficient implies that net accounts receivable are non-monotonically related to interest rate spreads for upstream firms, exactly as predicted by Proposition 2. If we test Proposition 2 using working capital, rather than net accounts receivable, we confirm the proposition with even higher significance.

In fact we plot the median firm's working capital in US against the spread in Panel A of Figure 2.2. In the same figure, Panel B and Panel C plot the 25^{th} and 75^{th} percentile firm, respectively. There is a clear hump shaped relation only for upstream firms.

2.5.4 Upstream Working Capital in Booms and Busts

At the onset of the Great Recession credit spreads increased dramatically and credit tightened with substantial effects on output. If the length of production chains increased during the boom and shortened during the contraction, according to our model of incentives, we would observe that working capital increased relatively more for upstream firms during the boom and declined relatively more for upstream firms during the contractions. In order to test this, we split our sample into two sub-periods, 2004–2006 and 2007–2009, which might be interpreted as "good times before the Great Recession" and "bad times in the Great Recession," respectively.

Using those sub-periods, we estimate the equations:

$$\text{avg growth } WC/OR_{i,04-06} = \beta_0 + \beta_1 \text{UPS}_{c,s} + \mu_c + \varepsilon_{i,t} \tag{2.22}$$

$$\text{avg growth } WC/OR_{i,07-09} = \beta_0 + \beta_1 \text{UPS}_{c,s} + \mu_c + \varepsilon_{i,t} \tag{2.23}$$

where avg growth $WC/OR_{i,07-09}$ and avg growth $WC/OR_{i,04-06}$ refer to the average growth rate of working capital normalized by operating revenue averaged over the periods 2007–2009 and 2004–2006, respectively. For any firm in our sample, the respective growth rates are constructed as the first difference of logarithmic values of WC/OR in 2007 and 2009 and as the first difference of logarithmic values of WC/OR in 2004 and 2006, respectively. $UPS_{c,s}$ refers to upstreamness value that proxies the vertical position of firms in supply chain in given country-sector pair. μ_c represents country dummies (fixed effects).

Table 2.11 displays OLS results. In Panel A, we find a positive and significant β_1, which implies that firms that are higher up in the production chain expand working capital during the high growth period. In Panel B, we find a negative and significant β_1, which suggests that firms higher up in the production chain contract working capital in the Great Recession. These results provides powerful indirect evidence of the necessity of a stronger role for incentives as production chains becomes longer or shorter following the business cycle.

Finally, we ask if the firms which increased working capital during the boom years, typically contracted working capital during the Great Recession. To examine this question, we estimate the regression

$$\text{avg growth } WC/OR_{i,07-09} = \beta_0 + \beta_1 \text{avg growth } WC/OR_{i,04-06} + \mu_c + \mu_s + \varepsilon_{i,t} \ , \tag{2.24}$$

where avg growth $WC/OR_{i,07-09}$ and avg growth $WC/OR_{i,04-06}$ refer to the average growth rate of working capital normalized by operating revenue averaged over the periods 2007–2009 and 2004–2006, respectively. For any firm in our sample, the respective growth rates are constructed as the first difference of logarithmic values of WC/OR in 2007 and 2009 and as the first difference of logarithmic values of WC/OR in 2004 and 2006, respectively. μ_c represents country dummies and μ_c represents sector dummies (fixed effects).

The results, presented in Table 2.12 indicate that firms that expanded working capital in the boom, contracted working capital in the Great Recession. The relation is statistically significant at the 5 percent level, but the coefficient of -0.012 is not very large.

2.6 Conclusion

This chapter has argued that working capital is the "glue" in production chains. When credit conditions are permissive in good times and interest rates are low, longer production chains become viable and more firms enter the production chain as upstream firms. However, when the interest rate rises dramatically during crises, the production chain shortens and upstream firms exit from the production chain. We have formulated a theoretical model and derive predictions for the relations between upstreamness and working capital and show how this relation is a function of interest rates.

Using a large-scale data set from ORBIS, we verify that upstream firms hold higher levels of working capital and (equivalently) net accounts receivable. We further verify the sharp theoretical prediction that the higher level of working capital in upstream firms is increasing in low interest rates but eventually decreasing as rates get high enough. We further demonstrate that upstream firms increased working capital in the high growth period of 2004-2006 and decreased working capital in the great recession. Finally, we show that the firms that increased working capital the more in the boom decreased working capital more in the recession.

There are many avenues for further research. One potential avenue is the role of finance in economic development. In an economy where the SME sector is well capitalized and financially sound, our model predicts that there are beneficial incentive effects of the SMEs supporting large balance sheets. Some European countries (notably Italy) and Japan have large and influential SME sectors while the United States is more vertically integrated. Korea may be an even more glaring example of an economy with extensive vertical integration. Of the forces that drive the push toward greater vertical integration, a shortage of working capital, implying a lack of incentives for upstream firms, may be one.

Table 2.2: Statistics on Payment Terms of Firms of Selected European Countries

Panel A:			
	(a)	(b)	(c)
Germany (1196)	65	23	18
Greece (540)	83	14	44
Ireland (496)	7	45	19
Portugal (505)	81	17	38
Spain (605)	71	27	31
Panel B:			
	(a)	(b)	(c)
Germany (1196)	1	14	18
Greece (540)	1	33	10
Ireland (496)	0.4	14	35
Portugal (505)	1	32	13
Spain (605)	1	22	21

Notes: Table 2.2 provides statistics on the payment terms of the firms of European countries, which are investigated by "Business Environment and Enterprise Performance Surveys" of World Bank in 2005. For each country, Panel A displays the percentage of the firms, which responded to the question "What percentage of your firm's sales' to customers in value terms over the last 12 months were **(a)** paid before the delivery of your products or services/**(b)** paid on delivery of your products or services/**(c)** sold on credit (payment due after the time of delivery of your products or services)?" as "0". In the same manner, Panel B displays the percentage of the firms, which responded to the same question as "100". The number of firms surveyed are given in the parentheses in each country's column.

Table 2.3: Mean Upstreamness Values of the OECD sample by Manufacturing Industries

NACE Rev 1.1. Code	Industry	Upstreamness (UPS)
15,16	Food products, beverages and tobacco	1.84
34	Motor vehicles, trailers and semi-trailers	1.88
33	Medical, precision and optical instruments	1.98
36	Manufacturing nec; recycling (include Furniture)	1.99
35	Building and repairing of ships and boats	2.03
29	Machinery and equipment, nec	2.04
30	Office, accounting and computing machinery	2.05
17,18,19	Textiles, textile products, leather and footwear	2.09
32	Radio, television and communication equipment	2.46
31	Electrical machinery and apparatus, nec	2.76
23	Coke, refined petroleum products and nuclear fuel	2.78
24	Chemicals excluding pharmaceutical	2.86
26	Other non-metallic mineral products	2.92
21,22	Pulp, paper, paper products, printing and publishing	2.93
28	Fabricated metal products, except machinery and equipment	2.97
20	Wood and products of wood and cork	3.10
25	Rubber and plastics products	3.11
27	Iron and steel	3.77

Notes: Table 2.3 displays mean upstreamness values by sub-industries of manufacturing industry. UPS is an industry measure of relative production-line position. We construct this value for each sub-industry of manufacturing industry for the given country in the OECD sample using the 2005 OECD Input-Output Tables from OECD STAN Database. Each individual mean upstreamness value is obtained by averaging the corresponding upstreamness values of the given sub-industry over all countries in the OECD sample. The sample consists of European OECD countries and the United States. The included European countries are Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Italy, Netherlands, Portugal, Slovakia, Slovenia and Spain. The first column presents the corresponding 2 digit NACE Revision 1.1 Primary Codes for the respective sub-industry of manufacturing industry.

Table 2.4: Firms Across Countries, 2000-2009: Number of Observations/Firms by Country

Country	Firm-Year	Number of Firms
Austria	1247	665
Belgium	30343	5495
Czech Republic	27792	7528
Denmark	4887	1515
Estonia	9141	1613
Finland	30633	5407
Germany	38527	14335
Greece	22128	6451
Hungary	10886	3539
Italy	282404	67605
Netherlands	3504	1076
Portugal	44378	11358
Slovakia	8305	2513
Slovenia	8814	1688
Spain	52436	10357
United States	40929	15723
Total	616354	156868

Notes: Table 2.4 displays the number of observations/firms from ORBIS with some financial data from selected OECD countries. Countries: Austria (AT), Belgium (BE), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), Germany (DE), Greece (GR), Hungary (HU), Italy (IT), Netherlands (NL), Portugal (PT), Slovakia (SK), Slovenia (SI), Spain (ES), the United States (US). Financial Data: All companies with a known value of 1) Operating revenue; and 2) Total assets; and 3) Accounts Payable; and 4) Accounts Receivable; and 5) Working Capital.

Table 2.5: Firms Across Countries, 2000-2009: Number of Observations/Firms by Type

Type	Firm-Year	Number of Firms
All	616354	156868
Medium	436963	114400
Large	140208	33742
Very Large	39183	8726
Listed	13094	2834
Unlisted	451594	107732
Young	72260	30107
Mature	530662	124472

Notes: Table 2.5 gives a breakdown of our sample into medium/large/very large; listed/unlisted; young/mature firms and provides the number of firm-year observations and the number of firms for each type. BvD defines medium, large, and very large firms as firms with employees more than 15, 150, and 1000, respectively. Listed firms are the firms quoted on a stock exchange. Mature firms are the firms that have been actively operating for at least ten years. Few firms do not have information on their legal status and/or date of incorporation, this explains why the numbers in the related groups do not add up to total number of firm-year observations and total number of firms.

Table 2.6: Descriptive Statistics: OECD Sample, 2000–2009

Variable	Obs.	Mean	Median	St. dev.	Min.	Max	Kurtosis
Payable/TA	606558	0.23	0.2	0.16	0.01	0.67	3.15
Receivable/TA	615650	0.33	0.31	0.19	0.02	0.76	2.45
Net Receivable/TA	606018	0.1	0.09	0.16	-0.29	0.5	3.11
Working Capital/TA	605153	0.28	0.28	0.19	-0.1	0.7	2.45
Short-term Debt/TA	595210	0.36	0.33	0.23	0.02	0.85	2.16
Bank Debt/TA	569870	0.22	0.20	0.19	0.00	0.68	2.25
Total Debt/TA	569757	0.46	0.47	0.24	0.03	0.91	1.99
Payable/OR	606722	0.18	0.16	0.12	0.01	0.52	3.2
Receivable/OR	615814	0.26	0.24	0.16	0.02	0.67	2.78
Net Receivable/OR	606182	0.08	0.07	0.13	-0.19	0.42	3.15
Working Capital/OR	605317	0.23	0.21	0.18	-0.07	0.74	3.33

Notes: Table 2.6 displays descriptive statistics for a pooled sample of European OECD countries and the United States, 2000–2009. The included European countries are Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Italy, Netherlands, Portugal, Slovakia, Slovenia, and Spain. The financial variables are divided by Total Assets (TA) or Operating Revenue (OR) to obtain the above ratios. All ratios are winsorized at 2% and 98%. See Section 2.4.2 for details on the definitions of those financial variables.

Table 2.7: Descriptive Statistics by Firm Types: OECD Sample, 2000–2009

Firm Type	Variable	Obs.	Mean	Median	St. dev.	Min	Max
Medium							
	Receivable/TA	436423	0.34	0.32	0.19	0.02	0.76
	Payable/TA	430238	0.24	0.21	0.16	0.01	0.67
	Receivable/OR	436587	0.27	0.26	0.16	0.02	0.67
	Payable/OR	430402	0.19	0.18	0.12	0.01	0.52
Large							
	Receivable/TA	140093	0.31	0.29	0.18	0.02	0.76
	Payable/TA	137753	0.21	0.19	0.14	0.01	0.67
	Receivable/OR	140093	0.24	0.22	0.15	0.02	0.67
	Payable/OR	137753	0.16	0.15	0.11	0.01	0.52
Very Large							
	Receivable/TA	39134	0.21	0.18	0.16	0.02	0.76
	Payable/TA	38567	0.14	0.1	0.13	0.01	0.67
	Receivable/OR	39134	0.18	0.15	0.12	0.02	0.67
	Payable/OR	38567	0.12	0.09	0.09	0.01	0.52
Unlisted							
	Receivable/TA	451376	0.33	0.32	0.19	0.02	0.76
	Payable/TA	443721	0.23	0.21	0.16	0.01	0.67
	Receivable/OR	451376	0.26	0.24	0.16	0.02	0.67
	Payable/OR	443721	0.18	0.17	0.12	0.01	0.52
Listed							
	Receivable/TA	13072	0.16	0.14	0.11	0.02	0.76
	Payable/TA	12930	0.09	0.07	0.09	0.01	0.67
	Receivable/OR	13072	0.17	0.15	0.11	0.02	0.67
	Payable/OR	12930	0.1	0.07	0.08	0.01	0.52

To be Continued.

Table 2.8: (Cont'd.) Descriptive Statistics by Firm Types: OECD Sample, 2000–2009

Firm Type	Variable	Obs.	Mean	Median	St. dev.	Min	Max
Young							
	Receivable/TA	72095	0.35	0.34	0.21	0.02	0.76
	Payable/TA	71004	0.28	0.25	0.19	0.01	0.67
	Receivable/OR	72127	0.26	0.23	0.17	0.02	0.67
	Payable/OR	71036	0.2	0.18	0.14	0.01	0.52
Mature							
	Receivable/TA	530142	0.32	0.3	0.18	0.02	0.76
	Payable/TA	522173	0.22	0.2	0.15	0.01	0.67
	Receivable/OR	530274	0.26	0.24	0.16	0.02	0.67
	Payable/OR	522305	0.18	0.16	0.12	0.01	0.52

Notes: Tables 2.7–2.8 display descriptive statistics for our OECD sample, 2000–2009, by firm types. BvD defines medium, large, and very large firms as firms with employees more than 15, 150, and 1000, respectively. Listed firms are the firms quoted on a stock exchange. Mature firms are the firms that have been actively operating for at least ten years. The financial variables are divided by OR (Operating Revenue) and Total Assets (TA) to obtain the above ratios. All ratios are winsorized at 2% and 98% before splitting into groups. We implement independent group t-test within each group to compare the mean values of the financial ratios across the respective two types. In each t-test, we have quite high t-statistics, which in turn suggest that the difference in means is statistically significantly different from zero at 1% level. See Section 2.4.2 for the details on the definitions of those financial variables.

Table 2.9: Testing Proposition 1

Dependent variables				
	$(\frac{REC}{OR})$	$(\frac{PAY}{OR})$	$(\frac{N\_REC}{OR})$	$(\frac{WC}{OR})$
UPS	0.014***	0.005***	0.009***	0.013***
	(47.29)	(21.23)	(31.65)	(32.62)
country fixed effects	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes
Adjusted R^2	0.335	0.318	0.079	0.097
Obs.	609497	600425	599886	599032

Notes: Table 2.9 reports the estimation results of Equation 2.20. The dependent variables $\frac{REC}{OR}$, $\frac{PAY}{OR}$, $\frac{N\_REC}{OR}$, and $\frac{WC}{OR}$ are calculated as "Accounts Receivable over Operating Revenue," "Accounts Payable over Operating Revenue," "Net Receivables (Accounts Receivable minus Accounts Payable) over Operating Revenue," and "Working Capital (Account Receivable plus Stock minus Account Payable) over Operating Revenue," respectively. UPS is an industry measure of relative production-line position. In all regressions, nonpermanent samples are used. Standard errors are robust and t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.10: Testing Proposition 2

Dependent variables								
	$(\frac{REC}{OR})$		$(\frac{PAY}{OR})$		$(\frac{N\_REC}{OR})$		$(\frac{WC}{OR})$	
UPS	0.015***		0.005***		0.010***		0.011***	
	(47.77)		(20.13)		(33.24)		(27.42)	
UPS×spread	0.018***	0.017***	0.010***	0.010***	0.008***	0.007***	0.014***	0.015***
	(8.52)	(8.32)	(6.23)	(6.25)	(3.70)	(3.46)	(5.06)	(5.44)
UPS×spread^2	-0.004***	-0.004***	-0.003***	-0.003***	-0.001*	-0.001**	-0.006***	-0.007***
	(-6.87)	(-7.13)	(-6.32)	(-6.20)	(-1.96)	(-2.29)	(-7.22)	(-8.11)
country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
sector fixed effects	no	yes	no	yes	no	yes	no	yes
Adjusted R^2	0.335	0.342	0.318	0.320	0.079	0.086	0.097	0.108
Obs.	609497	609497	600425	600425	599886	599886	599032	599032

Notes: Table 2.10 reports the estimation results of Equation 2.5.3. The dependent variables $\frac{REC}{OR}$, $\frac{PAY}{OR}$, $\frac{N\_REC}{OR}$, and $\frac{WC}{OR}$ are calculated as "Accounts Receivable over Operating Revenue," "Accounts Payable over Operating Revenue," "Net Receivables (Accounts Receivable minus Accounts Payable) over Operating Revenue," and "Working Capital (Accounts Receivable plus Stock minus Accounts Payable) over Operating Revenue," respectively. spread refers to BofA Merrill Lynch US Corporate AA Option-Adjusted Spread value. UPS is an industry measure of relative production-line position. In all regressions, nonpermanent samples are used. Standard errors are robust and t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2.11: Cross-Section Regressions: OECD sample, 2004–2009

Panel A: Dependent variable, average growth of $\frac{WC}{OR}$ (04–06)	UPS
UPS	0.029*
	(1.80)
Country fixed effects	yes
Adjusted R^2	0.018
Obs.	47414
Panel B: Dependent variable, average growth of $\frac{WC}{OR}$ (07–09)	**UPS**
UPS	-0.045***
	(-2.83)
Country effects	yes
Adjusted R^2	0.017
Obs.	47414

Notes: Table 2.11 reports the estimation results of Equations 2.22–2.23 in Panel A and B, respectively. In Panel A, the dependent variable; i.e., average growth rate of $\frac{WC}{OR}$ (04–06) refers to the growth rate of $\frac{WC}{OR}$ that is averaged in the period 2004–2006. The corresponding growth rate of $\frac{WC}{OR}$ is constructed as the first difference of logarithmic values of $\frac{WC}{OR}$ in 2004 and 2006. In the same manner, in Panel B, the dependent variable i.e. average growth rate of $\frac{WC}{OR}$ (07–09) refers to the growth rate of $\frac{WC}{OR}$ that is averaged in the period 2007–2009. The corresponding growth rate of $\frac{WC}{OR}$ is constructed as the first difference of logarithmic values of $\frac{WC}{OR}$ in 2007 and 2009. $\frac{WC}{OR}$ is calculated as "Working Capital over Operating Revenue." UPS is an industry measure of relative production-line position. In all regressions, nonpermanent samples are used. Standard errors are robust and t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

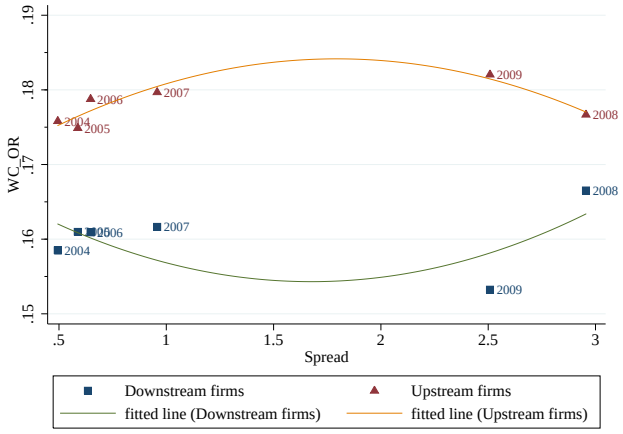
Table 2.12: Cross-Section Growth Regressions: OECD sample, 2004–2006

Dependent variable, average growth of $\frac{WC}{OR}$ (07–09)			
average growth of $\frac{WC}{OR}$ (04–06)	-0.013**	-0.012**	-0.012**
	(-2.57)	(-2.43)	(-2.38)
Country fixed effects	yes	yes	yes
Sector fixed effects	no	yes	yes
Clustered std. errors by	no	no	country
Adjusted R^2	0.011	0.018	0.018
Obs.	47860	47860	47860

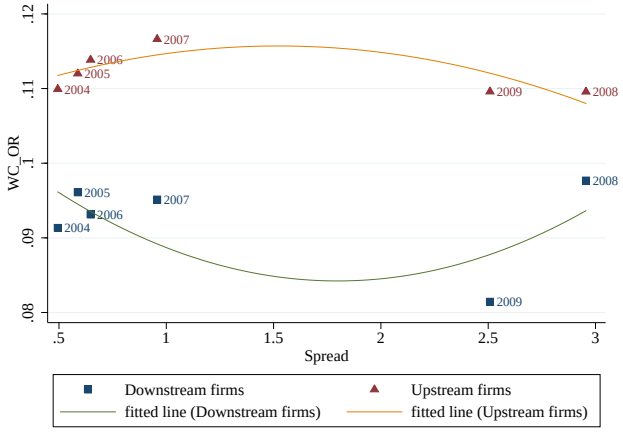
Notes: Table 2.12 reports the estimation results of Equation 2.24. The dependent variable i.e. average growth rate of $\frac{WC}{OR}$ (07–09) refers to the growth rate of $\frac{WC}{OR}$ that is averaged in the period 2007–2009. The corresponding growth rate of $\frac{WC}{OR}$ is constructed as the first difference of logarithmic values of $\frac{WC}{OR}$ in 2007 and 2009. In the same manner, average growth rate of $\frac{WC}{OR}$ (04–06) refers to the growth rate of $\frac{WC}{OR}$ that is averaged in the period 2004–2006. The corresponding growth rate of $\frac{WC}{OR}$ is constructed as the first difference of logarithmic values of $\frac{WC}{OR}$ in 2004 and 2006. $\frac{WC}{OR}$ is calculated as "Working Capital over Operating Revenue." In all regressions, non-permanent samples are used. Standard errors are robust and t-statistics are reported in parentheses. The standard errors are also clustered by country in the last column. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Figure 2.2: Testing Proposition 2

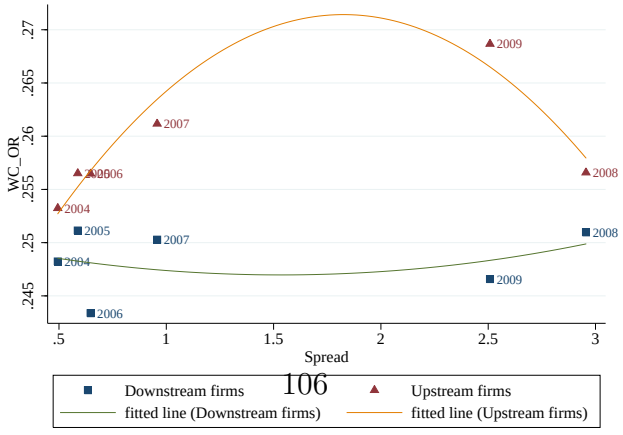
Panel A: Median Firm



Panel B: 25^{th} Percentile Firm



Panel C: 75^{th} Percentile Firm



Chapter 3

Leverage Across Firms, Banks and Countries

This chapter is a reprint from the article, "Leverage Across Firms, Banks and Countries," by Şebnem Kalemli-Özcan, Bent Sorensen, and Sevcan Yeşiltaş in *Journal of International Economics*, 88(2), 284-298, with permission from Elsevier.

3.1 Introduction

The 2007–2009 global crisis started in the financial sector and quickly turned into a global recession with a decline in output, employment, and trade unprecedented since the Great Depression. One lesson learned from previous emerging market crises is that banks' and firms' financing conditions are key mechanisms in turning financial crises into recessions: declining collateral values lead to higher cost of external financing which forces banks and firms to lower leverage and contract real investment leading to lower output (Kiyotaki and Moore (1997)). Procyclical leverage is therefore a potentially important amplification mechanism in propagating financial shocks to real economy (Bernanke and

Gertler (1995)). Many commentators have argued that the lending boom of the early 2000s, which fueled the run-up to the sub-prime crises, caused firms and banks to increase their leverage substantially. When the boom turned into a bust and banks deleveraged through contraction of credit, the global economic meltdown occurred.

A number of recent theoretical papers aim at understanding the endogenous leverage process (Farhi and Tirole (2010); Fostel and Geanakoplos (2008); Brunnermeier and Pedersen (2009)) but, to this date, leverage before and after the crisis has not been studied in the framework of an internationally comparative setting including listed as well as non-listed firms (financial and non-financial).[1] This is the task we undertake in this chapter by documenting leverage patterns across firms, banks, and countries during the 2000s. We examine if leverage patterns differ across firms and banks, across large and small banks, and across countries with different institutional and regulatory structures. In particular, we study which types of banks and firms were highly leveraged in which countries in the run-up to the crisis.

We utilize the most comprehensive and comparable firm-level and bank-level world-wide data set; namely, ORBIS from Bureau van Dijk Electronic Publishing (BvD) for the years 2000–2009 which covers listed, private, large, and small non-financial firms, financial firms, and banks. It is important to use micro data because aggregate country-level data may mask micro level patterns. Adrian and Shin (2008, 2009, 2010) and He, Khang, and Krishnamurthy (2010) investigate US commercial banks and investment banks mainly using aggregate

[1] The highly influential works of Adrian and Shin (2008, 2009, 2010) and Greenlaw, Hatzius, Kashyap, and Shin (2008) focus solely on the US

sectoral Flow of Funds data from the Federal Reserve. Sectoral data may be driven by the largest banks and it is important to know how typical investment and commercial banks behave. From a regulatory standpoint, the policy prescription will differ if aggregate leverage is driven by few large banks rather than by a large number of small and mid-size banks.

We show that leverage is procyclical for large commercial banks and investment banks in the US and to a lesser extent in Europe. Large banks have a comparative advantage in raising funds in short-term markets (overnight repurchase agreements and commercial paper) and they were able to increase leverage pre-crisis and skirt capital requirements by using off-balance sheet investment vehicles. Large banks may be somewhat more stable than investment banks due to their ability to obtain funds from depositors; nonetheless, excessive risk taking by huge "too-big-to-fail" banks, which are considered safe due to explicit deposit insurance and implicit government insurance, raises serious regulatory issues. Our main result is that excessive risk taking before the crisis was not easily detectable in aggregate data because pre-crisis increases in leverage were typical only for investment banks and very large banks in developed countries. These institutions grew their balance sheets aggressively by increasing debt and assets but the large risks taken became clear only after the crisis started. Banks in emerging markets behaved differently possibly due to tighter bank regulation. Using regression analysis, we show that banks in emerging markets had a tendency to grow leverage ratios less aggressively before the crisis and were able to better maintain their leverage ratios during the crisis.

Our results may have important policy implications especially with regards

to regulatory reform. Indeed, we find that banks in countries with tighter regulation deleveraged less when the crisis hit in 2008. This result is consistent with the finding of Beltratti and Stulz (2011) that banks from countries with tighter regulation performed better during the crisis as measured by stock prices.[2]

The remainder of this chapter proceeds as follows. Section 3.2 reviews the theoretical and empirical literature on leverage while Section 3.3 presents our data and discusses relevant issues. Section 3.4 presents the empirical patterns and regression results and Section 3.5 presents robustness analysis. Section 3.6 concludes.

3.2 Literature on Leverage

Since the celebrated paper of Modigliani and Miller (1958) there has been an outpouring of theoretical work on firms' capital structure but empirical work is only slowly catching up. Theoretical models pinpoint important departures from the Modigliani-Miller assumptions which make capital structure relevant for the value of firms. However, the empirical relevance of many theories is not established and the empirical evidence on capital structure outside the US is scarce because most of the literature uses data from COMPUSTAT on large listed US firms. The empirical literature is mostly cross-sectional and therefore doesn't address time-series dynamics in leverage patterns (see Frank and Goyal (2009) for an example).

The corporate finance literature studying US non-financial listed firms finds

[2]They consider very large listed banks with assets over 50 billion dollars.

that the most important cross-firm determinants of leverage are size, profitability, and tangibility (collateral). Rajan and Zingales (1995), using data for non-financial listed firms for the year 1991, show that these factors are also important for leverage in other G7 countries and that differences in accounting practices across countries do not substantially affect firms' leverage patterns although European firms have higher average levels of leverage compared to US firms. Booth, Aivazian, Demirguc-Kunt, and Maksimovic (2001) study ten developing countries using a data set of large listed firms in a static setting and find that size, profitability, and tangibility also are important for developing countries; however, there are significant country-level differences in mean levels of leverage. Lemmon, Roberts, and Zender (2008) undertake a dynamic analysis using data from COMPUSTAT and CRSP for listed US firms and conclude that more than 90% of the variation in leverage is captured by firm-fixed effects while the determinants identified by the previous cross-sectional literature only account for 10% of the variation—leverage is remarkably stable over time for listed non-financial firms.

In simple textbook theory, bank capital is determined by regulatory capital requirements. In more sophisticated models, banks optimize their capital structure responding to prices and pressures from shareholders and debtors in the same fashion as non-financial firms in a market economy as modeled by Flannery (1994), Flannery and Sorescu (1996), Myers and Rajan (1998), Diamond and Rajan (2000), and Allen, Carletti, and Marquez (2011). The recent theoretical literature on endogenous leverage stresses financial frictions: financial intermediaries face frictions in raising funds and when frictions worsen they sell

assets and reduce liquidity provision.[3] Leverage-constraint models, in which a tightening of constraints will lead to deleveraging, focus on the amount of debt financing of intermediaries; see, for example, Fostel and Geanakoplos (2008) and Brunnermeier and Pedersen (2009)

A rise in asset prices will mechanically increase the value of equity (banks' net worth) as a percentage of assets. Keeping everything else fixed, rising asset prices will lead to a lower leverage ratio, defined as the ratio of assets to equity. Conversely, in a downturn, asset prices would fall and the leverage ratio would increase. Adrian and Shin (2008, 2009, 2010) show that leverage patterns are countercyclical for the US non-financial sector but procyclical for investment banks. This procyclicality amplifies the business cycle, potentially leading to systemic risk, especially if asset prices do not properly reflect fundamental values ("bubbles"). Investment banks actively manage their balance sheet and leverage, typically through collateralized borrowing and lending, although this chapter does not explore how leverage is managed. For example, if the intermediary targets a constant leverage it will react to changes in net worth by adjusting debt. If balance sheets are not marked to market—as is typically the case for commercial banks—leverage is measured as total book assets to book equity. Banks can react to an increase in asset prices by increasing debt and assets, in which case the relationship between balance sheet leverage growth and the balance sheet size (asset growth) can be positive.

Flannery and Rangan (2008) and Gropp and Heider (2010) find large variation in banks' capital ratios and investigate whether capital requirements are a first-order determinant of banks' capital structure. Flannery and Rangan

[3]These models go back to the influential work of Shleifer and Vishny (1992).

(2008) show that banks increased capital holdings independently of regulatory requirements in the 1990s and interpret this as a reflection of reduced government implicit guarantees. Gropp and Heider (2010) undertake an analysis similar to that of Rajan and Zingales (1995) using BANKSCOPE data with both cross-bank and temporal variation as does the present article. They focus on the 100 largest listed European and US banks between 1991 and 2004 and find that the importance of size, profitability, and tangibility disappears once bank-fixed effects are accounted for. They also find that minimum capital requirements do not play a role in explaining banks' capital structure. Another important finding from the study of Gropp and Heider (2010) is that, on the margin, banks finance their balance sheet growth entirely from non-deposit liabilities. He, Khang, and Krishnamurthy (2010) emphasize the shifts in holdings of securitized assets within the financial sector and show that investment banks decreased leverage by selling assets during the deleveraging process of 2008–2009, commercial banks and the government increased leverage by acquiring these assets.

The empirical results of Adrian and Shin (2008, 2009) and Greenlaw, Hatzius, Kashyap, and Shin (2008) suggest that the largest banks manage their capital structure based on internal value at risk and not based on regulatory constraints, especially for financial intermediaries that strive to maintain a constant (maximal) risk exposure, often measured as Value at Risk (VaR), while maximizing earnings.[4] Leverage is high during boom times because perceived risk is low while leverage is low during contractions because risk is high with

[4]VaR is an estimate of a financial institution's worst case loss and is usually defined with respect to a confidence level of, say, 99%. VaR is defined such that the probability that losses on the asset portfolio exceed the value VaR is less than 1%.

increased volatility of asset prices.

Overall, it appears that determinants of non-financial firms' and banks' leverage are quite stable over time and across countries, though there exist significant country differences in leverage levels.

3.3 Data and Descriptive Statistics

3.3.1 Data

We use a unique data set composed of firm- and bank-level observations for 2000–2009 from the ORBIS database provided by BvD. This database is an umbrella product that covers other well-known databases from the same company such as AMADEUS (only European firms), ZEPHYR (worldwide mergers), BANKSCOPE (worldwide banks), and OSIRIS (worldwide listed firms). The time coverage of each firm/bank is a subset of the sample period, leading to an unbalanced panel.[5]

The database comes in two modules: "Financials," which provides financial information—both on- and off-balance-sheet and "Ownership/Corporate Tree," which provides information on foreign and domestic owners of each firm as well as all subsidiaries. In our original data set, we have 60,000 publicly quoted companies worldwide (OSIRIS), 30,000+ banks worldwide (BANKSCOPE), 29 million European companies from 46 countries (AMADEUS), 18+ million US and Canadian companies, 5+ million South and Central American companies, 6+ million companies in the Far East and Central Asia (mainly in Japan, Korea, China), and 790,000 African and Middle Eastern companies (ORBIS).

[5]We use ZEPHYR data to control for all firm mergers and acquisitions that happened during our sample.

We only use banks/financial firms and "large" non-financial firms in this study because small non-financial firms played no role in the onset of the crisis. In fact, we document that even large non-financial firms did not increase leverage before the crisis. For banks and financial firms, we use a benchmark world sample because we have representative universal coverage. However, for non-financial firms, we do not have a representative sample and coverage varies across countries so we focus on "large" firms (defined as firms with more than 150 employees) from Europe and the US which comprise the countries with best quality data and coverage. In Europe and the US, all corporations (listed or not) have to file with official registries. Our European coverage is good because companies have to file both unconsolidated and consolidated statements while the US coverage suffers from the fact that many firms only report consolidated statements.[6] For non-financial firms, we use unconsolidated accounts to avoid double counting and to improve comparability across countries while we use consolidated accounts for investment banks because they only report these. Adding consolidated statements (holding companies) for commercial banks does not alter our results.

We use two types of samples for both banks and firms: permanent and non-permanent. The non-permanent sample is used in the regression analysis and in the investigation of cross-sectional patterns. We made sure the non-permanent sample does not suffer from survivorship bias by assembling our panel data from individual cross-sections using historical, archived releases of the database. This is important since BvD erases the data on banks in BANKSCOPE from

[6]In addition to this issue, BvD has a relatively thin coverage for the US before 2007 even for consolidated accounts.

all previous years if the bank does not exist in the current year. They apply a similar practice to firms in AMADEUS and in ORBIS where they keep a firm in the data set for 5 years after it disappears and then erase it from the data for all years. Hence, the data has to be downloaded disk by disk for every year and not from the latest disk for all the previous years.

The permanent sample is used for time series figures. We have to use a permanent sample here otherwise we would not know if the patterns seen in leverage are due to entry and exit of banks and firms. The trade-off is that these permanent samples will suffer from survivorship bias. Permanent samples are defined as firms and banks with non-missing asset data throughout the period 2000–2009—Lemmon, Roberts, and Zender (2008) make similar choices.

In the context of leverage, our bank data from BANKSCOPE is used by Gropp and Heider (2010). In the context of the bank competition literature, it is used by Berger, Klapper, and Turk-Ariss (2009) and Claessens and Laeven (2004). Our firm data is used by many authors in different contexts. Arellano, Bai, and Kehoe (2010) study the relationship between leverage and financial development for one year (2004) using AMADEUS data but do not analyze dynamic properties of leverage. Coricelli, Driffield, Pal, and Roland (2009) use AMADEUS data to study the relation between growth and leverage in 9 CEE countries during the pre-crisis period 1996–2005. ORBIS, from where we get the US firms, is identical to the well-known Dun and Bradstreet data set for the US. For example, Black and Strahan (2002) use this data to study entrepreneurial activity in the US. The firm-level data is also used in two other studies involving two of the authors of this article; namely, Kalemli-Ozcan, Sorensen, and Volosovych (2014) who study the relationship between growth

and volatility and Fons-Rosen, Kalemli-Ozcan, Sørensen, Villegas-Sanchez, and Volosovych (2013) who study financial integration and productivity spillovers.

The bank-level and firm-level data sets are suitable for international comparisons because BvD harmonizes the data. Our dynamic analysis either compares banks over time within a single country or banks over time within a group of countries using bank and country-time fixed effects which control for permanent differences between banks or countries and for global common factors. For our purpose, it is important to undertake a dynamic analysis, rather than a cross-sectional analysis which doesn't allow for fixed effects, because country-fixed effects will absorb all features that are common to all banks and firms in a country such as differences in accounting practices, balance sheet representation, and domestic regulatory adjustments. For example, using international financial reporting standards results in higher total asset amounts reported than when US generally accepted accounting principles are used because netting conditions are stricter under international standards.

Regulatory requirements might apply differently across countries; for example, in the US minimum capital requirements apply both to individual banks and to consolidated banks, whereas in other countries this may be different. Investment banks and their subsidiaries in the US are regulated by the Securities and Exchange Commission (SEC) while other countries have different regulatory systems. Again, any non-time varying bank-level changes will be absorbed by our fixed effects.

Differences between countries can be due to assets and liabilities being valued at book value (historical) versus market value (current). If different countries follow different accounting practices but all banks and firms within each country

behave similarly then these differences will be absorbed by country fixed effects. If banks and firms in various countries behave differently in a fashion that changes over time then we cannot account for this with fixed effects. Therefore, we stick to book value overall as reported in balance sheets if we have a choice between the two as in the case of listed firms and banks. For private firms and banks, we have book value only.

We use country-level measures from the Bank Regulation Data Set of Barth, Caprio, and Levine (2007). This data set comes in surveys from 2003 and 2010, respectively. We use the 2003 values of the following variables: 1) "Supervision Index," which measures the efficiency of supervision and takes a value of 1 if there are multiple independent supervisors for banks and zero otherwise and 2) "Monitoring Index," which measures the efficiency of monitoring and takes a value of 1 if the top ten banks in the country are all rated by international rating agencies, if off-balance sheet items are disclosed to public, if banks must disclose risk management procedures to the public, and if subordinated debt is required as part of regulatory capital and zero otherwise. We expect banks in countries where the values of these indices are high to take lower risks in terms of asset quality because it is relatively harder to hide such risks on or off the balance sheet.

3.3.2 Descriptive Statistics

The leverage ratio is measured as the ratio of assets to equity (shareholder funds).[7] We explored other measures such as the ratio of Tier 1 capital (sum

[7] Our measure is equivalent to the measure 1−equity/assets used by Gropp and Heider (2010)

of capital and reserves minus intangible assets) to adjusted assets, the ratio of total liabilities to total assets, the ratio of total debt to total assets, and the ratio of total debt to equity. The patterns in those data series were mainly consistent with what we show in this paper and they are not reported in the present version of the article.

The leverage ratio does not reflect off-balance sheet exposure. One of the key characteristics of the sub-prime crisis is that in the pre-crisis period banks funded a growing amount of long-term assets with short-term liabilities through the use of off-balance sheet vehicles, exposing themselves to credit and liquidity risk by providing credit facilities and guarantees to these vehicles. Many have argued that this was the main amplification mechanism (see Brunnermeier (2009) and Adrian and Shin (2009)). In addition, many banks held structured credit instruments on their balance sheet, increasing the maturity mismatch of their balance sheet and their funding liquidity risk. We investigate patterns in the ratio of off-balance sheet items (guarantees and committed credit lines) to assets because a loan guarantee involves a future contingent commitment even if it does not show up on the balance sheet. Banks report these data together with the balance sheet as a separate memo line called off-balance sheet items where they report guarantees, committed credit lines, and other exposure to securitization. Very few banks report the last item and investment banks do not report any of these items.

Tables 3.1–3.2 show the number of bank-year and firm-year observations by country. We have over 200,000 bank observations and over one and a half million firm observations from 60+ countries. Table 3.3 presents the number of observations by bank type and account type. Most of our banks are commercial

banks and most of our banks report unconsolidated accounts. The majority of banks are not listed. Most of the firms in our sample are non-financial, unlisted firms reporting unconsolidated accounts.

Tables 3.4–3.5present descriptive statistics for the data as used in the regression analysis—this data set is winsorized at 2% and 98%. The leverage ratio is as high as 46 with a mean of about 12 while the maximum amount of off-balance sheet items is more than 11 times of assets, although the mean across banks is only 0.7%. Tables 3.4–3.5 also show descriptive statistics by type of bank. Investment banks have slightly higher leverage on average. "Sponsor"banks and large commercial banks have the highest leverage on average at around 23 and 17, respectively.[8]

3.4 Empirical Patterns

3.4.1 Aggregate Picture

In Figure 3.1, we plot bank assets since 2000. Panel A shows sectoral data from the Flow of Funds accounts compiled by the US Federal Reserve System. As shown, assets of commercial banks, savings institutions, and credit unions increased from about 6 trillion dollars in 2000 to over 12 trillion dollars in 2008 followed by a decline of several hundred billion since 2008. Investment banks ("brokers and dealers" in the Flow of Funds, which includes all institutions who are engaged in brokering and dealing of securities) saw tremendous growth

[8] "Sponsor banks" are large banks which have created off-balance sheet investment vehicles. We obtained the names of the sponsor banks from Acharya, Schnabl, and Suarez (2013). There are 70 conduit sponsor banks in their data set and we have located 62 of these in our data. 31 of these banks are European, 23 are American, 4 are Australian, 3 are Japanese, and 1 bank is Canadian. Only 3 out of 62 are investment banks. Non-sponsor banks statistics are similar to the statistics of all banks.

in assets from 2000 to 2008 followed by a steep reversal of over half a trillion dollars.[9] The travails of the US investment banks culminating in the default of Lehman Brothers have been extensively documented in many places, see for example Duffie (2010), Krishnamurthy (2010), and other papers in the *Journal of Economic Perspective*'s symposium on the financial crisis in the Winter 2010 issue.

Panel B displays bank assets, aggregated from our bank-level data, for the US. In this article, we use the label "aggregated" for data summed over the banks in our sample. Total Assets of each bank is defined as total book value of intangible, tangible, and other fixed assets. Compared to the Flow of Funds data, our aggregated data overstates assets because banks' claims on each other are not netted out. Nonetheless, the patterns in our aggregated data are similar to the patterns in the Flow of Funds data for both investment banks and non-investment banks. Using our data, we are able to break down the patterns for large banks, large banks excluding investment banks, and small banks. We define a large bank as a bank that has more than a billion dollars worth of assets at the beginning of our sample. Panel C shows aggregated assets of the European banks in our data set: assets grew marginally from 2000 till 2004 followed by a sharp acceleration to more than 20 trillion dollars in 2008 followed by an astounding drop of about 3 trillion dollars from 2008 to 2009.[10]

Looking at risk-weighted assets may be more informative about risk taking and we do so in Figure 3.2. A clear divergence in the trend between total

[9] There may be brokers and dealers in the Flow of Funds that are not "investment banks" in the BvD data; however, there is a large overlap between the categories.

[10] The European sample includes all European countries. Results with EU banks only are similar.

assets and risk-weighted assets can be observed for all banks and as well as for large banks (aggregated from micro data), with risk-weighted assets growing more slowly. Risk-Weighted Assets (RWA) are defined as the sum of three components: operational risk, market risk, and a weighted sum of assets with appropriate weights determined by the regulators. The weights can be chosen in a simplified manner or in a more sophisticated manner which is typically used by large banks. The weights assigned in the simplified system are 0 for government and other public assets, 20% for liabilities of other banks and securities firms, 35% for secured mortgages, 75% for personal lending, and 100% for corporate and commercial lending. A more sophisticated system includes more subcategories based on credit rankings.[11] Risk-weighted assets give an indication of the degree of measured risks regulators believe banks take; however, the low rate of increase in risk-weighted assets compared to total assets imply that the risk that became evident during the crisis was not captured by the risk-weights applied to banks' assets in the period leading up to the sub-prime crisis. Figure 2 shows that the risks that became evident during the crisis were not captured by the risk-weights applied to banks' assets in the period leading up to the sub-prime crisis as risk weighted assets displayed lower growth rates before the crisis.[12]

Figure 3.3 displays bank equity, in a similar fashion to Figure 1, using the sectoral Flow of Funds data for the US in Panel A, and using aggregated data (aggregation of bank-level observations for the US banks) in Panel B. Equity of US investment banks grew sharply from 2004 to 2006 followed by a sharp drop

[11] See Blundell-Wignall and Atkinson (2010) for more details.

[12] Plotting the assets of the median bank, rather than aggregated assets, results in a similar picture.

in 2008 (the exact timing being slightly different between the quarterly Flow of Funds data and the annual aggregated data). For large banks (excluding investment banks) there has been a steady increase in assets. For European banks, aggregated equity (displayed in Panel C of Figure 3.3) increased rapidly from about 600 billion dollars in 2004 to about 800 billion in 2007 followed by a slight drop in 2008 and a recovery in 2009.

Figure 3.4 compares aggregate US leverage, calculated as assets over equity, from the Flow of Funds to aggregated leverage compiled from our micro data, in Panels A and B. The US patterns from the Flow of Funds in Panel A are very similar to those of the aggregated data in Panel B which display aggregated assets divided by aggregated equity. In 2004, the SEC deregulated the minimum capital requirements for investment banks, freeing leverage ratios from direct regulatory constraints. A run-up in leverage of investment banks ("brokers and dealers" in the Flow of Funds) from 2004 to 2008 is evident in both panels although the Flow of Funds data, being quarterly, exhibits sharper peaks and valleys. The collapse in the leverage of investment banks after 2008 is clearly evident in both panels. This is mechanically explained by the sharp decline in assets combined with equity rebounding in 2009. Leverage ratios of commercial banks were quite stable from 2000 until 2008 when a steep decline occurred. This is mechanically explained by the small decline in assets and the steeper increase in equity seen in the previous figures. Panel C shows similar patterns for the European banks. Table B.2 shows aggregated, mean, and median leverage for 2006–2009 for other countries.

Aggregate patterns may be driven by a few mega-banks, such as Bank of

America, Citibank, and JP Morgan. Our micro data allows us to examine leverage of typical banks. We plot median leverage for banks over time in Figure 3.5. Panel A is visually dominated by investment banks which have pro-cyclical leverage ratios between 14 and 20. These medians are higher than those of commercial banks but much lower than the aggregate leverage ratios of investment banks—clearly, high leverage of investment banks is concentrated within the largest banks. Panel B shows that the median European bank decreased leverage steadily from around 17.5 to 15 over our sample.

The sub-prime crisis first came to the surface on July 31, 2007 with the default of two Bear Stearns hedge funds followed by BNP Paribas halting withdrawals from three investment funds. A large number of banks had created off-balance sheet conduits which mainly invested in asset-backed securities in order to reduce capital requirements. However, most conduits were still fully or partially guaranteed by their sponsoring banks which also provided committed lines of credit (see Acharya, Schnabl, and Suarez (2013) for more details on this). We have measures of guarantees and committed credit lines and we display the aggregated amounts relative to assets for all banks and separately for large banks in Figure 3.6. Investment banks do not report these items. The total amount of guarantees and credit lines at 85% were almost as large as total assets from 2000 till 2007 for large banks and lower at 70% for all banks. From 2007 till 2009 there was a sharp drop with the aggregate amount falling to less than 50% of assets when banks were getting out of these commitments in the wake of the interbank lending freeze and the difference between larger and smaller banks narrowed. Panel B shows similar patterns for Europe in terms of timing, though less pronounced in terms of scale: guarantees and committed

credit lines never exceeded 22% of assets in Europe. This is partly due the differences in regulation: banks in Spain do not issue guarantees to off-balance sheet entities because Spain had imposed similar capital requirements for assets on- or off-balance sheets, leaving little incentives for Spanish banks to use such entities.

Guarantees and credit lines are not the focus of this article but it appears that banks carry a large amount of risk that is not visible from conventional leverage ratios. Ex post, major US banks were subject to increasing risk from guaranteeing enormous pools of assets of declining quality; however, the pattern of Figure 6 does not indicate increased risk taking before 2007—only the collapse after the start of the crises reveals the risk taken. It is clear that outside of investment banks neither leverage nor guarantees and committed credit lines relative to assets (or equity) signalled excessive risk taking over time in the run-up to the crisis. It appears that the increasing risk exposure of commercial banks in 2004–2007 were hidden in the deteriorating quality of the asset pool. Figure 3.7 shows median levels of guarantees and committed credit lines to assets for large banks and for all banks. The median is much smaller than the aggregate ratio for large banks and much smaller again for all banks. This holds for both the US and Europe implying that issuing of guarantees and committed credit lines was concentrated among the largest banks which disproportionately affect the mean.

3.4.2 Bank Leverage: Procyclical or Countercyclical?

An increase in asset values will mechanically increase the value of both the numerator and denominator of the leverage ratio but the increase in equity

will be proportionally larger and the leverage ratio will fall. Such a pattern is observed for households as pointed out by Adrian and Shin (2008, 2009). However, a firm or a bank may be able to use the increased equity as basis for further lending which will increase assets (and liabilities) relative to equity with the outcome that asset appreciation and leverage is no longer inversely related. Adrian and Shin (2008, 2009) demonstrate that non-financial corporations' asset growth and leverage is virtually uncorrelated using aggregate data from the US Flow of Funds accounts.

A non-financial firm may face decreasing marginal profitability of investments; however, banks will often be able to invest with non-decreasing marginal returns in large liquid markets, such as the market for mortgage-backed securities, while borrowing at a constant low rate through repurchase arrangements, commercial paper, or implicitly through cash management for hedge funds. If banks have target leverage ratios, leverage will not increase with asset values but if banks target a level of risk exposure, leverage may be procyclical as Adrian and Shin (2008, 2009) find for US investment banks 1963–2006. They find an acyclical pattern for commercial banks, although Greenlaw, Hatzius, Kashyap, and Shin (2008) found a procyclical pattern for 5 big commercial banks in the US. We do not explore models of how banks determine their leverage in this chapter but Figure B.4 shows that aggregate leverage tends to move inversely with the US VIX-index of risk.[13]

Figure 3.8 examines potential procyclicality for US investment banks, and

[13]VIX is the symbol for the Chicago Board Options Exchange Market Volatility Index, which measures the implied volatility of S&P 500 index options.

large commercial banks in Panels A, and B, respectively. The figure complements Adrian and Shin (2008, 2009) and Greenlaw, Hatzius, Kashyap, and Shin (2008), plotting average growth of leverage against average growth of assets for the sample of all (investment, and large) banks in our data set. In these figures, all banks have equal weight and the interpretation is that the figures show whether typical banks display the "Adrian-Shin pattern."[14] Because all banks have equal weights, the patterns are not strongly affected by a few giant banks. We include a 45 degree line along which points will cluster if banks maintain a constant level of equity implying that assets and leverage move in lock step.

Panel A focusses on US investment banks and the "Adrian-Shin pattern" is easily visible over the full sample period. Year 2008 is an outlier with large declines in assets and leverage but it pretty much lies on the line that one can easily fit using ordinary myopic eyeballs.[15] For large US (non-investment) banks in Panel B, a similar pattern is visible, maybe with an even steeper slope although the observations for 2008 and 2009, which are above the other points, probably should be interpreted with caution: many observers, see for example, Greenlaw, Hatzius, Kashyap, and Shin (2008), interpret the increase in bank lending in 2008 as "forced lending" where borrowers were drawing on pre-committed credit lines. Certainly, the steep decline in assets, committed credit lines, and guarantees that started in 2008 and accelerated in 2009 is consistent with banks needing time to unwind their obligations. For smaller

[14]This is different from saying that the median bank displays the pattern. In the time series graphs, we plotted medians against time but it is not as meaningful to plot median leverage growth against median asset growth because the medians will belong to different banks.

[15]Note that in the figures in Adrian and Shin's articles 2008 is the peak year. This discrepancy to our results occurs because they use first quarter of 2008 where the crisis was still in its infancy. Our annual data is from end-of-year accounts.

banks, we do not find procyclicality and we omit results smaller banks for space considerations. For European banks, we observe a slight tendency for leverage to be pro-cyclical for large banks, although with a much smaller slope than found for large US banks. Smaller European banks display a surprisingly stable level of asset growth and no hint of procyclical leverage. These results are available upon request.

3.4.3 Non-Financial Firms

Mean values of leverage for large non-financial firms over time are plotted in Figure B.1. Mean firm leverage for listed US firms is very stable at around 2.3-2.4 while the leverage ratio is slightly larger for non-listed firms but still much lower than for banks. This pattern is consistent with firms hoarding cash in 2009 (for example, Almeida and Campello (2007) discuss how constrained firms may be more likely to conserve cash in a recession drawing on their bank lines of credit). For Europe, we see slightly higher leverage ratios, which may be due to differences in accounting rules, but the temporal patterns are similar to those of the US with very little variation over time except that we find a weak but steady decline in leverage for all (mainly non-listed) firms. The great recession does not register at all for European non-financial firms. Non-financial firms showed no inkling of procyclicality and very little systematic growth of leverage. We do not show these results for space issues.

3.4.4 Regression Analysis

From the previous section, it appears that leverage at the bank and firm level did not signal an impending recession. In this section, we examine if leverage

patterns differed between countries with looser or stricter regulation.

We estimate the relation

$$\text{Leverage}_{it} = \mu_i + \Sigma_t \gamma_t D_t + \Sigma_t \beta_t \, D_t * X_{c(i)} \ ,$$

where the left-hand side is firm-level leverage, μ_i indicates firm-level dummies ("fixed effects"), D_t is a set of time dummies (with 2000 left out to avoid collinearity), and $X_{c(i)}$ is one of the regulatory variables that captures intensity of bank regulation in country c in which bank i is located.[16] The bank-level dummies capture any constant bank-level (and therefore also country-level) variables and the non-interacted time dummies capture world wide impacts in each year. The objects of interest are the β_t coefficients which show whether countries with particular regulatory environments experience different temporal patterns in leverage.

The temporal patterns in Table 3.6 are revealing: the time-dummy interaction terms are in general not significant for 2001 to 2008 (meaning these years are similar to 2000) except for the Monitoring Index (for all banks) for which leverage is lower during 2001–2008 than 2000 in countries where these variables are higher (meaning stricter regulation). More interesting is the result that more restrictive regulation is associated with a relatively higher leverage in 2009.[17] We interpret this in the light of the time series patterns observed in the figures. Banks with high leverage and relatively risky assets displayed strongly declining leverage after 2008 when assets were written down. As discussed previously,

[16] In a previous version, we controlled for size (log assets), profitability, and collateral because these were found by Gropp and Heider (2010) to be predictors of bank leverage but because those variables may be endogenous, we include only the variables of interest in this version, including bank fixed effects to account for unobserved bank heterogeneity.

[17] At the time of this writing, the data set is not complete for 2009 where our sample is significantly smaller than in the other years, so the results are subject to this caveat.

standard leverage measures did not flag that the assets on many banks' balance sheets were questionable—this only became apparent when assets lost significant value in 2008 and 2009. If a restrictive regulatory environment helped banks stay on a straight and narrow path in terms of asset quality, this should be visible only when the banks in lightly regulated countries were deleveraging during the crisis. The positive coefficient associated with strict regulation implies that countries with strict regulation deleveraged less which we interpret to mean that banks in those countries on average held higher quality assets and/or avoided risk exposure through guarantees to off-balance sheet entities. The coefficient to, say, Supervision Index of 0.291 implies that a change from less restrictive to more restrictive leads to a change in the leverage ratio of about 0.3. If the initial leverage ratio was 0.9 the new leverage predicted ratio is 1.2—a rather substantial increase in leverage. Or rather, substantially less deleveraging because all results are relative. The implication is that the underlying problems in asset quality and, therefore, the vulnerability of the real economy may be significantly impacted by regulatory constraint.

3.5 Robustness and Other Issues

3.5.1 Other Determinants of Leverage: Banks and Firms

What about the role of cash holdings? Figures B.2–B.3 display median and aggregate cash holdings of US banks and European banks, respectively. For the US, cash holdings increased slower than aggregate assets before the crisis but this would not have signalled an increase in risk taking. The US data displays a highly pronounced spike in 2009 which reflects the breakdown of interbank

lending during the crisis when the interbank lending market froze as banks' feared that counter-parties might be in danger of failure. The banks, therefore, held assets on their books leading to the spike in cash while the Federal Reserve lent directly to banks needing short-term financing.[18] For Europe, the picture is one of steadily increasing cash holdings, roughly mirroring the increase in assets.

We performed firm-level regressions for non-financial firms but there was no visible increase or decrease in leverage of the non-financial firms before and/or after the crisis. We have checked whether this can be explained by firms' cash holdings but cash holdings do not display significant time variation. These results are available upon request.

3.5.2 The Role of Conduits

Acharya, Eisert, Eufinger, and Hirsch (2014) show that commercial banks set up conduits to securitize assets—specifically Asset Backed Commercial Paper (ABCP)—without transferring risk to outside investors. These conduits were designed to avoid capital charges and commercial banks facing more stringent capital requirements were more likely to set up conduits with guarantees implying that risk was not transferred outside of the banking system.

Conduits are independent shell companies sponsored by large financial institutions.Acharya, Eisert, Eufinger, and Hirsch (2014) use a hand-collected data set on the universe of conduits from January 2001 to December 2008 and their

[18] In order to limit any potential inflationary impact of the large reserves the Federal Reserve, for the first time in its history, began paying interest on reserves in October 2008. In effect, the Federal Reserve acts as an intermediary between banks with excess funds and banks wishing to lend. This mechanism is explained in detail in Keister and McAndrews (2009).

sponsors. They show that almost all conduits have credit guarantees issued by large financial institutions. We do not have these conduits in our data but we have the sponsors. The data on guarantees and committed credit lines displayed previously include the credit guarantees to conduits because these are explicit commitments of the sponsor banks. Acharya, Eisert, Eufinger, and Hirsch (2014) report that investors in conduits only lost 1.7% of their investments in ABCP because guarantees were called and the assets were liquidated and looses absorbed by the sponsoring banks. Our figures are consistent with this fact. Thus, it is clear that much of the deleveraging process is closely linked to these conduits and their sponsor banks.

Did banks with conduits have different leverage? Most conduit sponsor banks are large commercial banks: only 3 out of 62 sponsors in our data are investment banks. In order to investigate if sponsor banks had different leverage on their balance sheets, we plotted all our figures dropping all conduit sponsor banks from our permanent sample. This had very little effect on the figures which therefore are not reported.

3.5.3 The Role of Mergers and Government

During the crisis, several large commercial banks acquired investment banks, notably JP Morgan's takeover of Bear Stearns in 2008 and Bank of America's takeover of Merrill Lynch in January 2009. We do not control for these mergers which took place mid to end of 2008/beginning of 2009. It is most likely the case that the mergers will not cause an immediate increase in the assets of the commercial bank but over time, as the securities held by the acquired banks are transferred, we should see a rise in the assets of the commercial bank. Thus, this

is a potentially important issue if we want to trace changes in leverage and assets through the end of 2010 since Bank of America's and JP Morgan's assets may increase as a result of the acquisitions. The same issue may effect the acquired banks but He, Khang, and Krishnamurthy (2010) do not observe any change in Merrill Lynch's asset holdings in the first quarter of 2009. Other investment banks were not acquired but ceased to be investment banks and converted into bank holding companies, in particular Goldman Sachs and Morgan Stanley but even after being converted into holding company status, the commercial banking operations represent a very small fraction of the business of these banks.

The government played a very active role in recapitalizing banks. He, Khang, and Krishnamurthy (2010) suggest that the preferred stock owned by the government must be subtracted from equity in calculating "true leverage." They find, using data from the Federal Deposit Insurance Corporation, that such a correction raises the leverage of the top 19 commercial banks in the US from 10.0 to 14.4 in the first quarter of 2009. They further argue that "true leverage" may have been as high as 30 if assets were marked to market. While they were able to roughly impute the fall in the value of banks' asset during the peak of the crises for the commercial banking sector as a whole and for some major banks, it is not easy to do so systematically bank-by-bank over our sample and hence we do not perform such an exercise. We also do not perform an adjustment on the government owned stock because if the purpose of measuring leverage is to gauge the riskiness of banks, surely government owned preferred equity helps buffer risk. We report asset and equity holdings and leverage of big investment and commercial banks from the US and Europe in Table 3.7. Our numbers match He, Khang, and Krishnamurthy (2010) for investment banks but for

commercial banks we find a smaller increase in 2008 because we do not adjust for government owned equity. A final difference is that they focus on subsidiaries and, most likely unconsolidated statements, since they drop holding companies. (One has to use either consolidated or the non-consolidated statements in order to avoid double counting.) In our empirical analysis, we use unconsolidated accounts for non-investment (commercial) banks and for investment banks we use consolidated accounts throughout because these banks only report consolidated statements. For the purpose of Table 3.7, we use consolidated statements and include holding companies for both commercial and investment banks in order to make a meaningful comparison between the two groups.

3.6 Conclusion

Traditional leverage ratios and off-balance sheet exposure did not signal high levels of risk taking by commercial banks the US and other countries before the sub-prime financial crises. However, investment banks in the US and large European banks with investment banking arms aggressively increased leverage, especially after the SEC 2004 deregulation in the US.

Our results are not informative about whether banks knowingly took high risk. Nonetheless, when the crisis broke in 2007–2008, the banks in countries with large exposure to sub-prime assets suffered large declines in assets. There was little relation between leverage and restrictiveness of regulation across countries before 2008 but the countries with stricter bank regulation were less affected by the crises implying that regulation may well have benefits even if these benefits are invisible until the economy faces a major stress event.

Table 3.1: Firms and Banks Across Countries, 2000–2009: Number of Observations by Country

Country	Bank-Year	Firm-Year (Europe and US Only)
ARGENTINA	1404	
AUSTRALIA	1384	
AUSTRIA	2996	5225
AZERBAIJAN	180	
BANGLADESH	412	
BELGIUM	1420	67385
BOSNIA	249	
BRAZIL	2248	
BULGARIA	333	11585
CANADA	963	
CHILE	547	
CHINA	993	
COLOMBIA	507	
COSTA RICA	861	
CROATIA	509	11277
CZECH REPUBLIC	449	37078
DENMARK	1812	23231
EGYPT	478	
EL SALVADOR	272	
ESTONIA	160	5847
FINLAND	350	32318
FRANCE	6809	182857
GEORGIA	125	
GERMANY	22981	104191
GHANA	337	
GREECE	472	
HONG KONG	1647	
HUNGARY	553	21703
ICELAND	262	2163
INDIA	1318	
INDONESIA	846	
IRELAND	914	13141
ISRAEL	332	
ITALY	9891	163632
JAPAN	10079	

To be continued.

Table 3.2: Firms and Banks Across Countries, 2000–2009: Number of Observations by Country

Country	Bank-Year	Firm-Year (Europe and US Only)
KENYA	671	
KOREA REP. OF	810	
LATVIA	365	6399
LITHUANIA	198	6564
LUXEMBOURG	1617	2592
MALAYSIA	1514	
MEXICO	770	
NETHERLANDS	1345	29182
NEW ZEALAND	280	
NORWAY	1474	30479
PARAGUAY	230	
PERU	395	
PHILIPPINES	718	
POLAND	695	72030
PORTUGAL	765	34732
ROMANIA	366	16891
RUSSIA	5889	154729
SERBIA	345	19796
SINGAPORE	816	
SLOVAKIA	290	7989
SLOVENIA	337	4239
SOUTH AFRICA	980	
SPAIN	3069	133102
SWEDEN	1343	81489
SWITZERLAND	6104	4646
TAIWAN	1237	
THAILAND	661	
TURKEY	946	
UKRAINE	555	16099
UNITED KINGDOM	6533	183959
URUGUAY	464	
USA	112116	139026
VENEZUELA	619	
TOTAL	229610	1675576

Notes: Banks are defined broadly to include financial firms such as credit card companies, private equity firms, hedge funds, broker-dealers, specialized credit institutions, etc. Firms are non-financial firms from Europe and the US with more than 150 employees.

Table 3.3: Firms and Banks Across Countries, 2000–2009: Observations by Type

BANKS

	World	Europe	US
All	30056	14680	13964
Investment	975	402	138
Commercial	29081	14278	13826
Consolidated	6826	2612	3246
Unconsolidated	23201	10978	10606
Listed	3351	1164	1074
Unlisted	26705	13516	12890

FIRMS

	Europe	US
All	227295	53666
Financial	1466	6632
Non-Financial	225829	47034
Consolidated	42451	16486
Unconsolidated	184844	37180
Listed	10476	8875
Unlisted	216819	44791

Notes: Consolidated and unconsolidated refer to the number of banks/firms with consolidated and unconsolidated statements, respectively. Listed indicates the number of banks/firms that are listed on a stock exchange. Financial firms are firms with Primary NACE Rev. 1.1 sector code J: Financial intermediation.

Table 3.4: Descriptive Statistics; 2000–2009: All/Investment/Large-Investment Banks

Panel A: All Banks				
	N	Mean	Min	Max
Leverage Ratio	180460	12.4	1.3	46.3
Total Assets (billion USD)	180553	11.5	0	3663.3
Adjusted Assets (billion USD)	141669	9.3	-36.9	3318.9
Equity (billion USD)	180504	0.8	-92.9	3472.3
Off Balance Sheet (ratio of Total Assets)	79573	0.0	0	5.2

Panel B: Investment Banks				
	N	Mean	Min	Max
Leverage Ratio	4101	13.6	1.3	46.3
Total Assets (billion USD)	4103	26.6	0	1599.6
Adjusted Assets (billion USD)	1890	32.2	0	1258.2
Equity (billion USD)	4103	1.1	-9	106
Off Balance Sheet (ratio of Total Assets)	34	0.1	0	1.9

Panel C: Large Non-Investment Banks				
	N	Mean	Min	Max
Leverage Ratio	33664	17.4	1.3	46.3
Total Assets (billion USD)	33673	38.9	0	3663.3
Adjusted Assets (billion USD)	20837	35.4	0	2332.6
Equity (billion USD)	33667	2.8	-92.9	543.5
Off Balance Sheet (ratio of Total Assets)	1601	0.0	0	1.7

Notes: See Table 3.5 for explanations.

Table 3.5: Descriptive Statistics; 2000–2009: Sponsor/Non-Sponsor Banks

Panel D: Sponsor Banks				
	N	Mean	Min	Max
Leverage Ratio	404	22.7	1.3	46.3
Total Assets (billion USD)	404	490.3	0.1	3335.8
Adjusted Assets (billion USD)	366	514.2	0.1	3318.9
Equity (billion USD)	404	22.8	-1.8	198
Off Balance Sheet (ratio of Total Assets)	11	0.0	0	0.1

Panel E: Non-Sponsor Banks				
	N	Mean	Min	Max
Leverage Ratio	180056	12.4	1.3	46.3
Total Assets (billion USD)	180149	10.4	0	3663.3
Adjusted Assets (billion USD)	141303	8	-36.9	3318.8
Equity (billion USD)	180100	0.7	-92.9	3472.3
Off Balance Sheet (ratio of Total Assets)	79562	0.0	0	5.2

Notes: The data is winsorized at 2% and 98% before splitting into groups which explains why some extreme values are identical. In Panel A, statistics are given for all banks while Panels B and C display statistics for investment and large non-investment banks, respectively. Panel D displays statistics of conduit sponsor banks. The names of the sponsor banks are taken from Acharya, Schnabl, Acharya, and Richardson (2009). There are 70 conduit sponsor banks in their data set, of which we have located 62 in our data set. 31 of these banks are European, 23 are US, 4 are Australian, 3 are Japanese and 1 bank is Canadian. In Panel E, non-sponsor bank statistics are shown separately. Leverage ratio is defined as the ratio of total assets to equity. Totals assets are composed of tangible and intangible assets. Adjusted assets exclude goodwill and intangibles. Equity is measured as shareholder funds. Off-Balance sheet items are the sum of guarantees and committed credit lines. A "large bank" has more than one billion dollars worth of assets in 2000. All non-ratio items are in 2005 dollars.

Table 3.6: Bank Leverage: 2000–2009, World Sample

Dependent Variable:	Bank Leverage		
	(1)	(2)	(3)
Bank Sample	All	All	Large
Regulatory/Institutional (R/I) Framework	Supervision Index	Monitoring Index	Monitoring Index
2001× R/I Framework	0.012**	–0.005*	-0.007
	(0.005)	(0.003)	(0.005)
2002× R/I Framework	0.006	–0.011***	-0.006
	(0.006)	(0.003)	(0.006)
2003× R/I Framework	–0.010	–0.014***	0.001
	(0.007)	(0.004)	(0.006)
2004× R/I Framework	–0.003	–0.011***	-0.002
	(0.007)	(0.004)	(0.007)
2005× R/I Framework	–0.013*	–0.011**	-0.009
	(0.008)	(0.004)	(0.009)
2006× R/I Framework	–0.048***	–0.021***	-0.017
	(0.009)	(0.005)	(0.011)
2007× R/I Framework	–0.054***	–0.024***	-0.016
	(0.009)	(0.005)	(0.011)
2008× R/I Framework	–0.011	–0.009	0.007
	(0.01)	(0.007)	(0.012)
2009× R/I Framework	0.291***	0.140***	0.073***
	(0.056)	(0.051)	(0.019)
Bank dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
R^2	0.008	0.008	0.015
N	172344	136360	22116

Notes: Leverage is the logarithm of total assets over equity. Standard errors in parentheses, clustered at the bank level. The main regressors are country-level variables that capture the regulatory and institutional framework (the exact variable name is given in each column's heading), interacted with time dummies. Column (3) limits the sample to large banks with more than a billion dollars in assets in 2000. All regression variables are winsorized at 2% and 98%. 2000 is the omitted year. Supervision index measures the efficiency of supervision and takes a value of 1 if there are multiple independent supervisors for banks and zero otherwise. Monitoring index measures the efficiency of monitoring and takes a value of 1 if top ten banks in the country are all rated by international rating agencies, if off-balance sheet items are disclosed to public, if banks must disclose risk management procedures to the public, and if subordinated debt is required as part of regulatory capital. This index is zero otherwise. These variables are from the Barth, Caprio, and Levine (2007), Bank Regulation and Supervision Data Set. See Table 1 for the set of countries in the world sample.

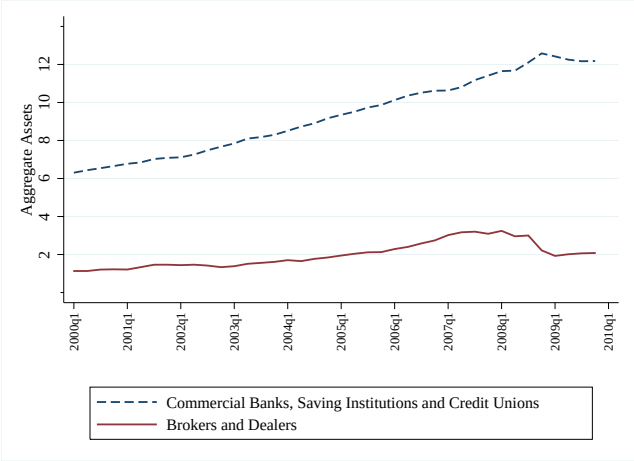
Table 3.7: Leverage of Very Large Banks

	(2007)			(2008)		
	Assets	Equity	Leverage	Assets	Equity	Leverage
Bank of America	1616	138.3	11.7	1648.9	160.6	10.3
Bear Stearns	372.4	11.1	33.5	N.A.	N.A.	N.A.
Citigroup	2060.5	112	18.4	1758.2	130.6	13.5
Goldman Sachs	1054.7	47.2	22.4	802.3	59.9	13.4
JP Morgan	1471.4	116.9	12.6	1972.8	152.4	12.9
Lehman Brothers	650.9	21.2	30.7	N.A.	N.A.	N.A.
Merrill Lynch	960.8	30.1	31.9	605.5	18.1	33.4
Morgan Stanley	984.7	29.5	33.4	597.6	46.1	13
Wells Fargo	542	45.1	12	1187.9	92.8	12.8
BNP Paribas	71.4	4.8	14.9	N.A.	N.A.	N.A.
Barclays	2073.8	54.1	38.3	3335.7	77	43.3
Deutsche Bank	2315.9	47.3	49	N.A.	N.A.	N.A.
Fortis Bank	331.3	27.3	12.1	N.A.	N.A.	N.A.
RBS	3211.1	154.5	20.8	3051.3	76.8	39.7
UBS	1.5	0.2	6.4	N.A.	N.A.	N.A.

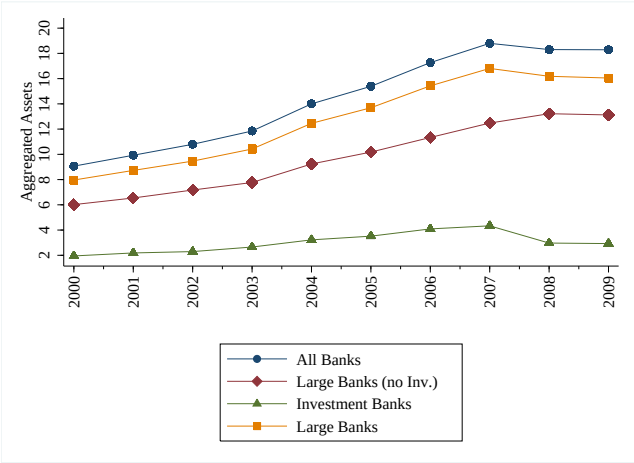
Notes: Leverage is defined as the ratio of total assets to equity. Total assets are composed of tangible and intangible assets. Equity is measured as shareholder funds. All non-ratio items are in billion 2005 dollars.

Figure 3.1: Financial Sector Assets

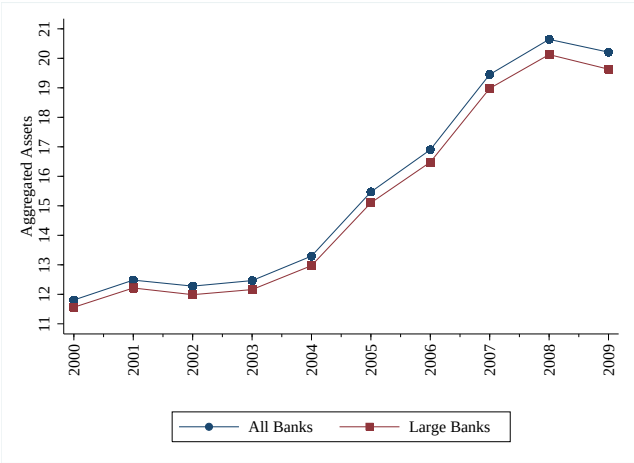
Panel A: Flow of Funds Data: US



Panel B: Bankscope Micro Data, Aggregated: US

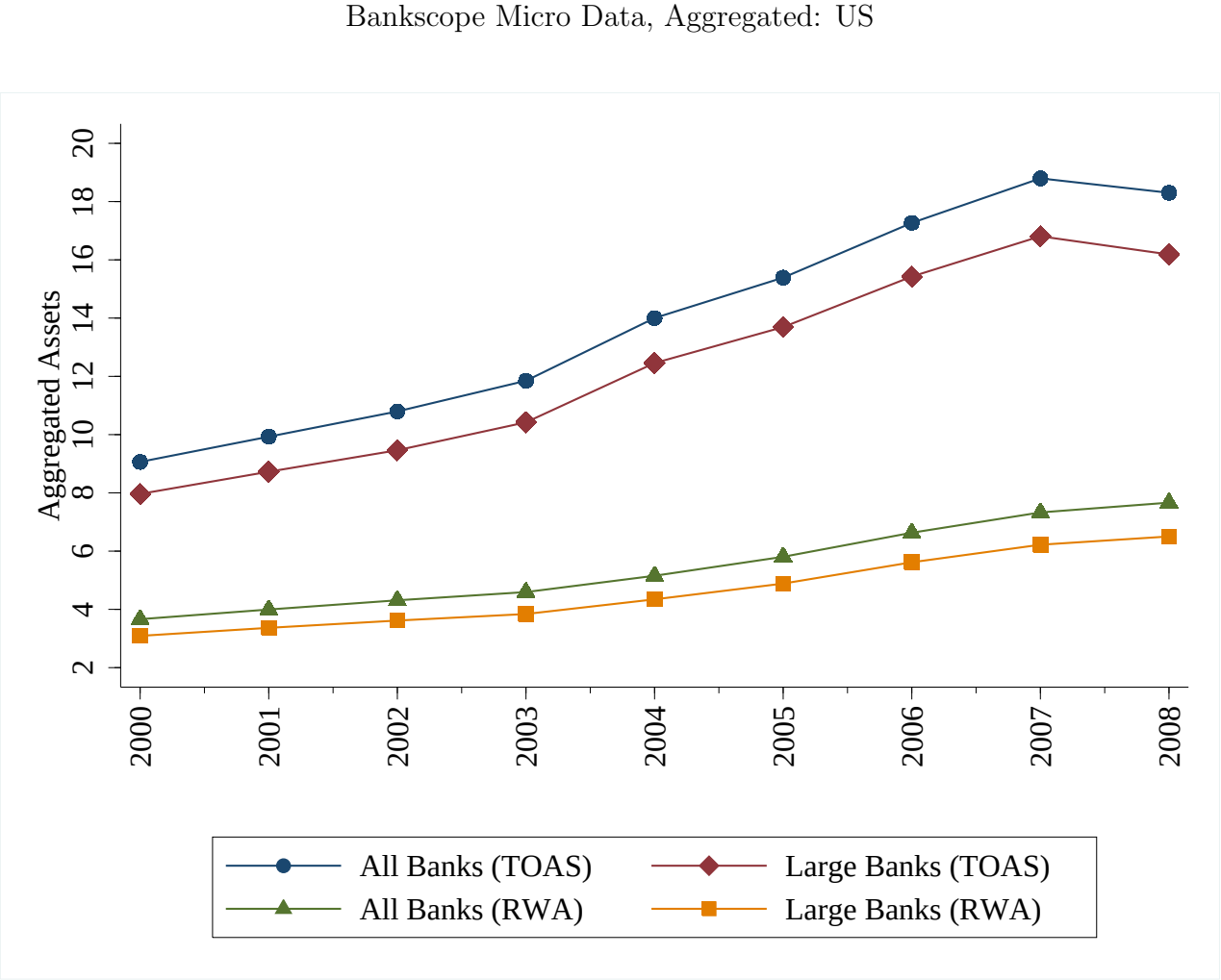


Panel C: Bankscope Micro Data, Aggregated: Europe



Notes: Panel A displays financial sector assets from the Flow of Funds. The numbers are in trillion 2005 dollars, deflated by the GDP deflator. Panels B and C display total assets aggregated from our bank-level data for different group of banks for US and Europe, respectively. The numbers are in trillion 2005 dollars, deflated by the consumer price index. Total assets is defined as total book value of intangible, tangible, and other fixed assets. A "large bank" has more than one billion dollars worth of assets in 2000.

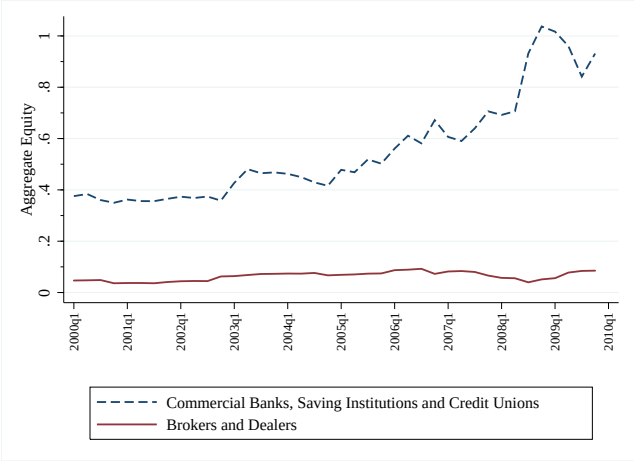
Figure 3.2: Risk Weighted versus Non-Risk Weighted Assets



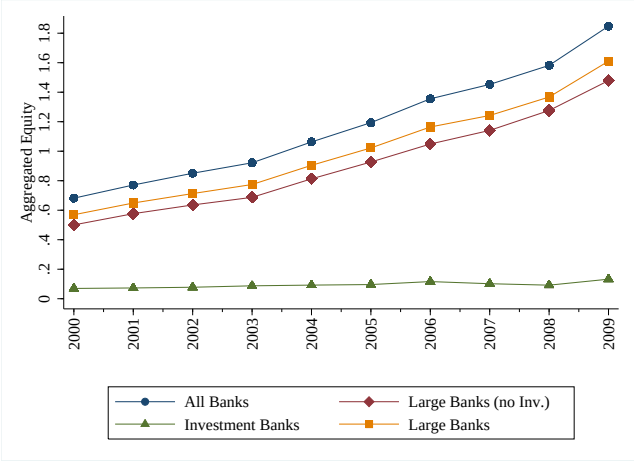
Notes: The data plotted is aggregated from bank-level data and is denominated in trillion 2005 dollars. Total assets (TOAS) is defined as total book value of intangible, tangible, and other fixed assets. Risk-Weighted Assets (RWA) are weighted according to riskiness with weights determined by regulators. Bank can choose weights according to a "simple rule," for which the weights are 0 for government and other public assets, 20% for liabilities of other banks and securities firms, 35% for secured mortgages, 75% for personal lending, and 100% for corporate and commercial lending. A "sophisticated rule," used by larger banks, include more subcategories based on credit rankings; see Blundell-Wignall and Atkinson (2010) for more details. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure 3.3: Financial Sector Equity

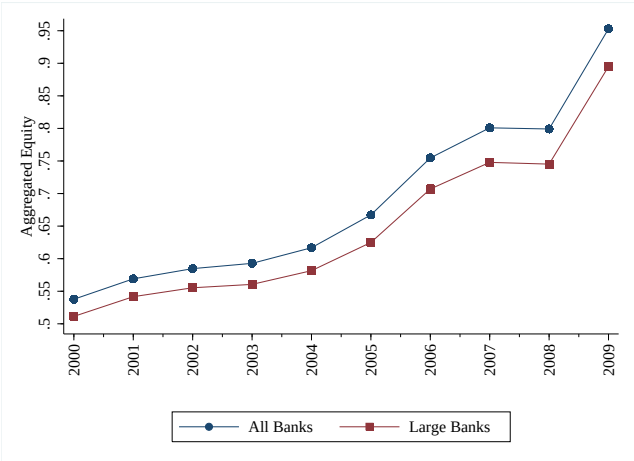
Panel A: Flow of Funds Data: US



Panel B: Bankscope Micro Data, Aggregated: US



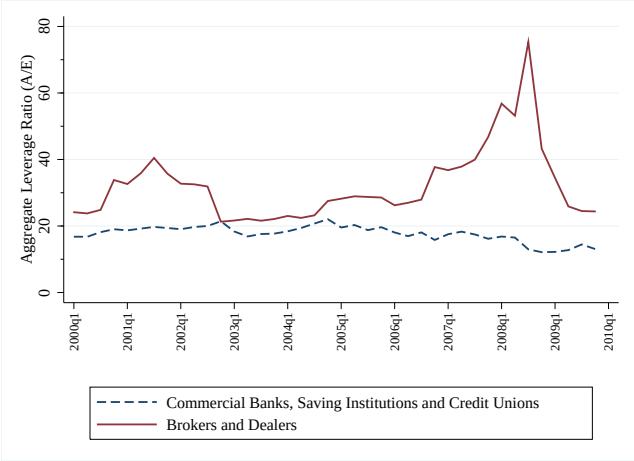
Panel C: Bankscope Micro Data, Aggregated: Europe



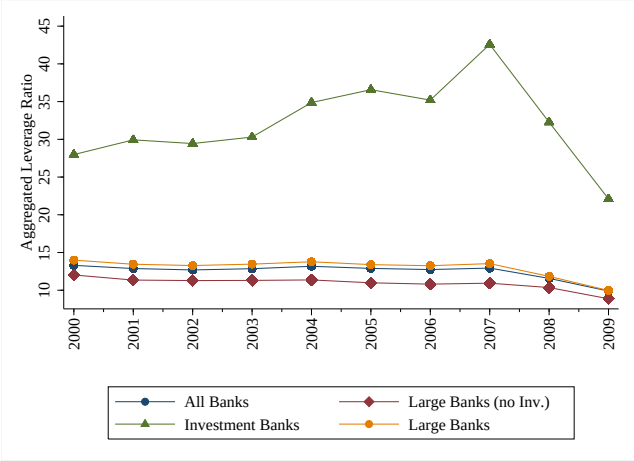
Notes: Panel A displays financial sector equity from Flow of Funds data. The numbers are deflated by the GDP deflator and displayed in trillion 2005 dollars. Panels B and C display banks' equity aggregated from our bank-level data for different group of banks in the US and Europe, respectively. The numbers are deflated by the consumer price index and is reported in trillion dollars. Equity is measured as shareholder funds. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure 3.4: Financial Sector Leverage Ratio

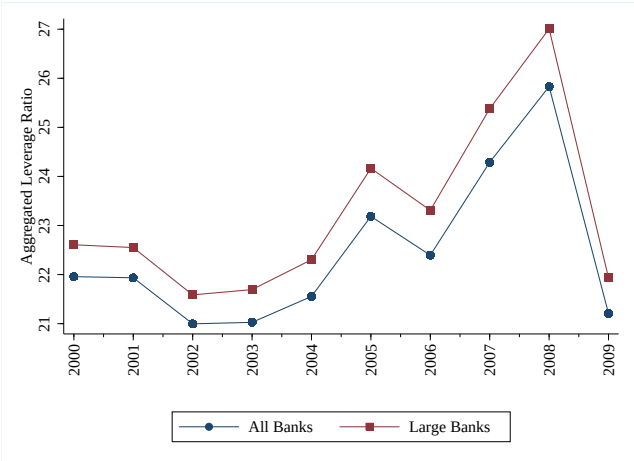
Panel A: Flow of Funds Data: US



Panel B: Bankscope Micro Data, Aggregated: US



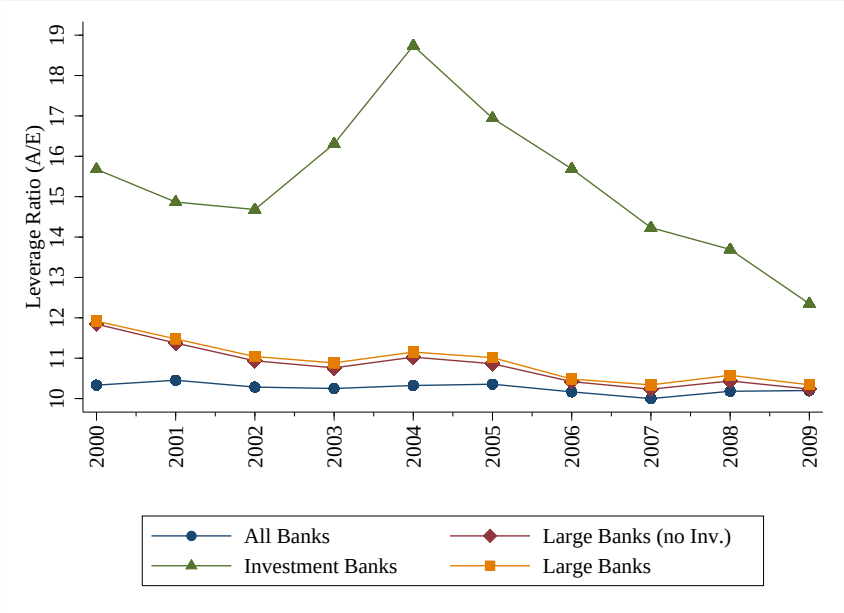
Panel C: Bankscope Micro Data, Aggregated: Europe



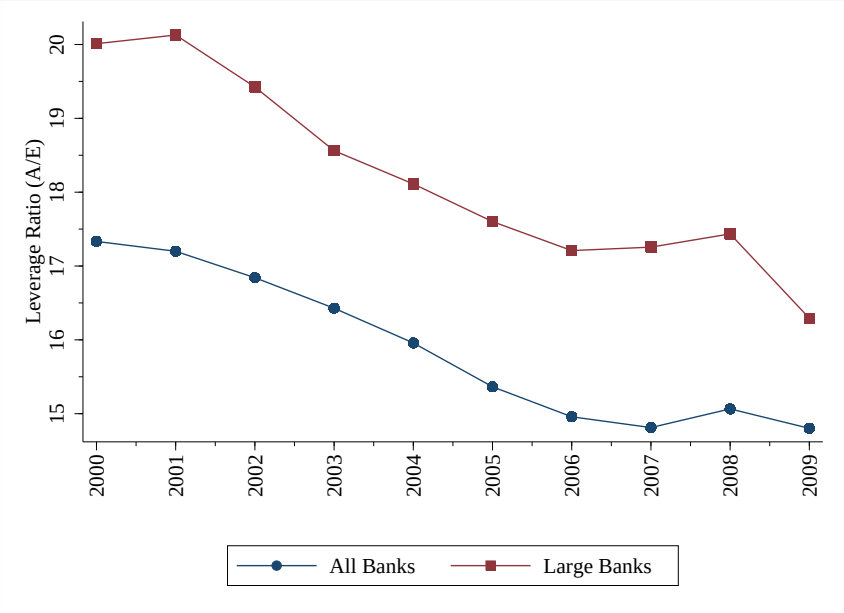
Notes: Panel A displays financial sector leverage ratio in the US, calculated as assets over equity, using sectoral data from the Flow of Funds. Panels B and C display leverage ratios, calculated from bank-level data for the US and Europe, respectively. We aggregate bank-level assets and equity for different group of banks and take the ratio of aggregated assets to aggregated equity. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure 3.5: Financial Sector Leverage Ratio: Typical Bank

Panel A: Bankscope Micro Data, Median: US



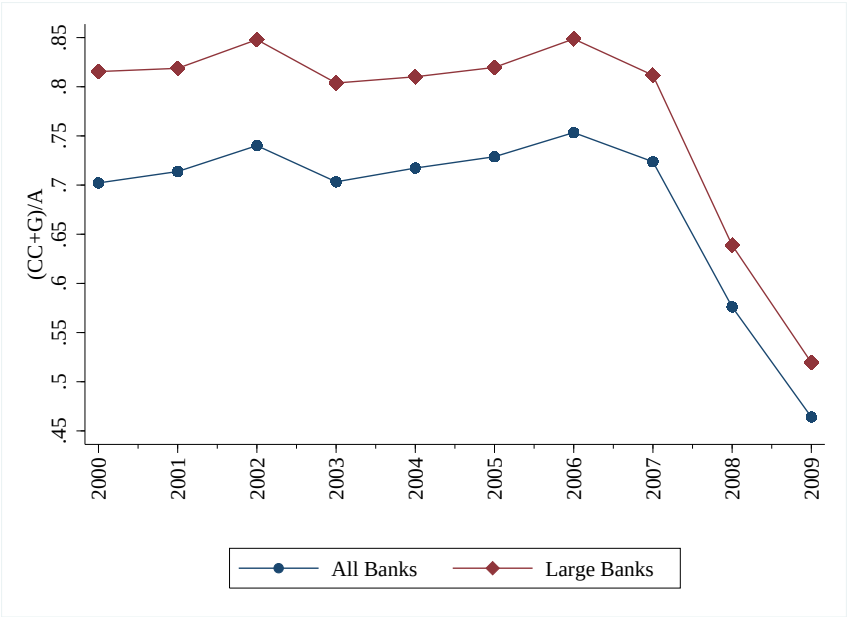
Panel B: Bankscope Micro Data, Median: Europe



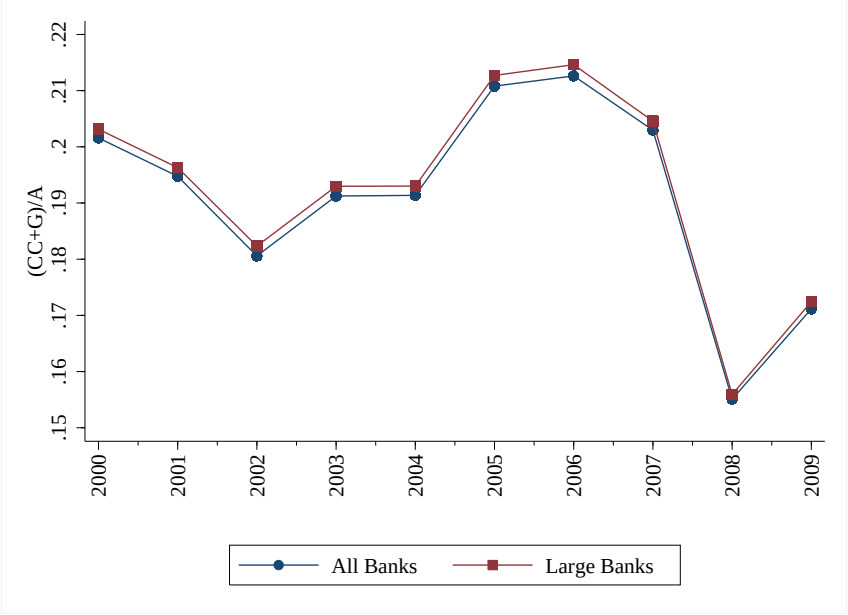
Notes: Panels A and B display median leverage; that is, the leverage ratio for the typical bank in the US and Europe, respectively. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure 3.6: Financial Sector Off-Balance Sheet Items

Panel A: Bankscope Micro Data, Aggregated: US



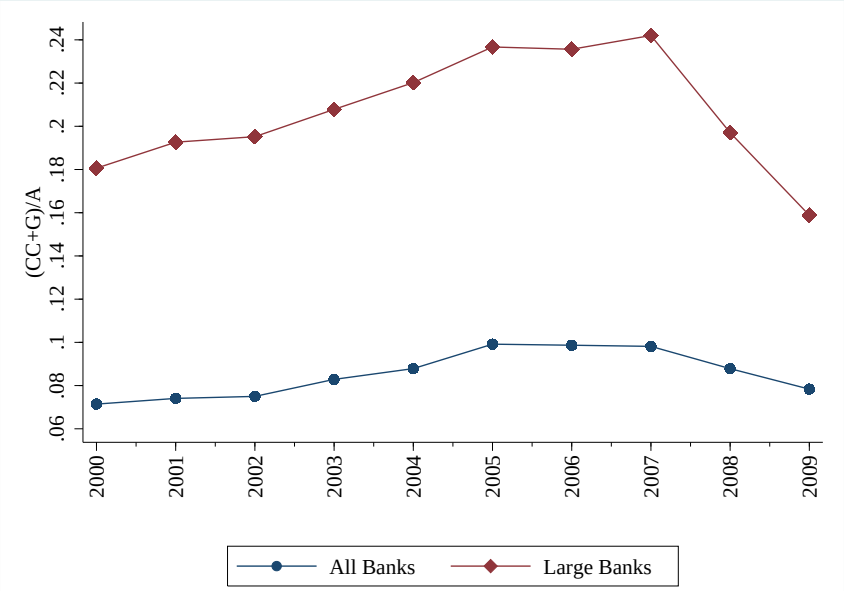
Panel B: Bankscope Micro Data, Aggregated: Europe



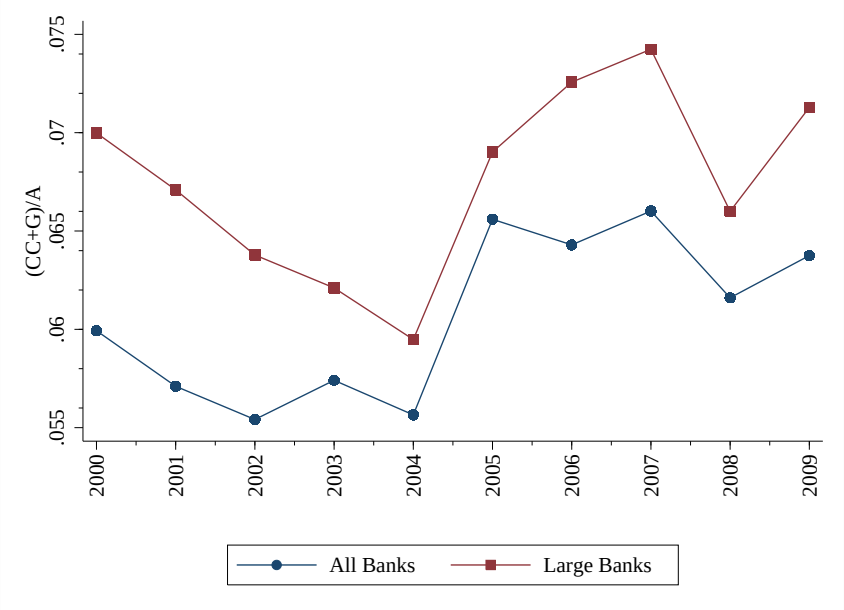
Notes: Off-balance sheet items (book value) come from three summary lines in the balance-sheet: acceptances, documentary credits, and guarantees. The number of banks reporting acceptances is very limited. We use committed credit lines and guarantees for off-balance sheet items. Panels A and B display aggregated off-balance sheet items, as a ratio of total assets, for all banks as well as large banks for the US and Europe, respectively. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure 3.7: Financial Sector Off-Balance Sheet Items: Typical Bank

Panel A: Bankscope Micro Data, Median: US



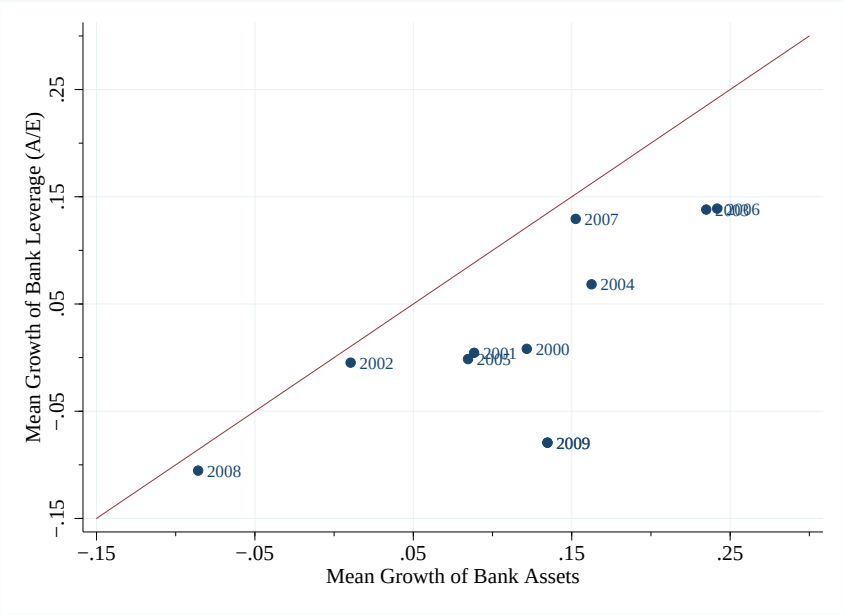
Panel B: Bankscope Micro Data, Median: Europe



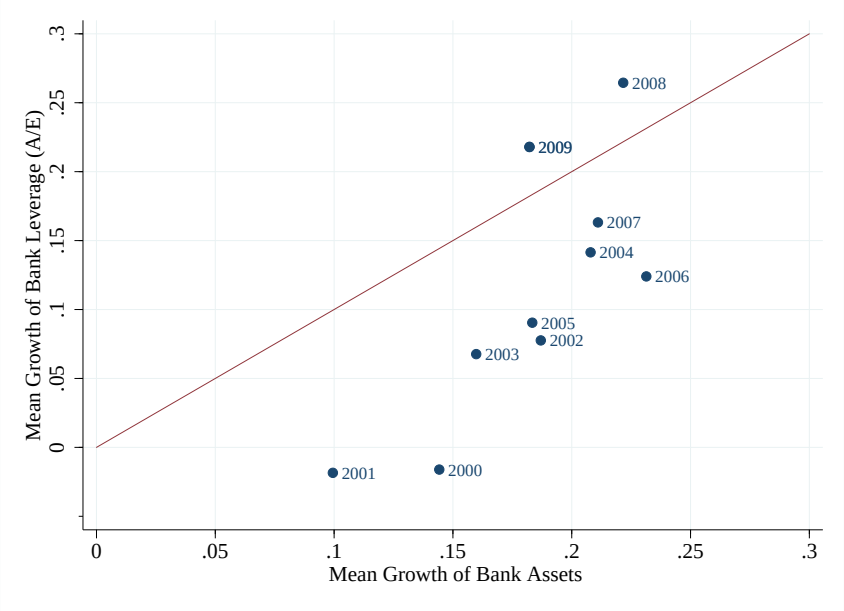
Notes: Off-balance sheet items come from three summary lines in the balance-sheet in book value: Acceptances, documentary credits, and guarantees. The number of banks reporting acceptances is very limited. We use committed credit lines and guarantees for off-balance sheet items. Panels A and B display median off-balance sheet items as a ratio of total assets for all banks as well as large banks in the US and Europe, respectively. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure 3.8: Financial Sector Procyclical Leverage Ratio: US

Panel A: Bankscope Micro Data, Mean: US Investment Banks



Panel B: Bankscope Micro Data, Mean: US Large Banks (exc. inv.)



Notes: Panels A and B plot the growth rate of bank leverage, defined as growth rate of assets over equity, against the growth rate of assets for US investment banks and large US banks excluding investment banks, respectively. A 45 degree line is plotted for easy reference. The growth rates are the mean growth rates across banks for each year. See notes to previous figures (and/or appendix) for exact definitions of the variables.

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Appendix A

Appendix for Chapter 1

A.1 Data Cleaning Process

The dataset I use in this paper combines firm-level information across different BvD products (ORBIS disk 2005, ORBIS disk 2009, ORBIS disk 2013, AMADEUS online 2010 from WRDS, and AMADEUS disk 2014). I clean the data in four steps. First, I clean the raw data off basic reporting mistakes. Second, I restrict this data to the one I use in my analysis and verify the internal consistency of balance sheet information. Third, I apply further quality checks (paper specific cleaning steps) and construct two different samples: Full Sample and Permanent Sample. Lastly, in each of these samples, we winsorize the variables used in the analysis.

A.1.1 Steps to Clean Basic Reporting Mistakes

I implement the following steps to clean the raw data off basic reporting mistakes.

1. I drop firms if any detail of assets/liabilities/capital, and sales, operating revenue, wage bill and depreciation is negative in any year.

2. I drop firms if they report sales, operating revenue, total assets, the sum of shareholderfunds and liabilities, and shareholder's capital as zero in any year.

3. I drop firms if employment is either zero or if employment is negative or greater than 2 millions in any year.

4. I drop firms if any of total assets, total liabilities and shareholder funds is missing in all years they report data to BvD.

A.1.2 Steps to Construct the Main Sample

1. For a given firm ORBIS–AMADEUS provides financial statements regarding different consolidation codes i.e. C1, C2, U1 and U2.[1] Given this fact, I dropped C2 accounts to avoid double accounting in our analysis.[2]

2. I first drop firms with missing information regarding their industry of activity. Second, I drop financial, real-estate firms. I also drop firms operating in the sectors outside SNA production boundary (NACE Rev. 2 sectors T & U).

3. I drop state-owned firms.

4. I drop firms with missing information on the variables used in benchmark analysis.

[1] C1: account of a company- headquarter of a group, aggregating all companies belonging to the group (affiliates, subsidiaries, etc.), where the company headquarter has no unconsolidated account, C2: account of a company-headquarter of a group, aggregating all companies belonging to the group (affiliates, subsidiaries, etc.) where the company headquarter also presents an unconsolidated account, U1: account of a company with no consolidated account, and U2: account of a company with a consolidated account.

[2] The number of firms with C1 accounts in the final sample is very limited.

5. I drop years with observations less than 1000 in a given country.

A.1.3 Internal Consistency of Balance Sheet Information

I check the internal consistency of the balance sheet data by comparing the sum of variables belonging to some aggregate to their respective aggregate. I construct the following ratios:

1. The sum of tangible fixed assets, intangible fixed assets, and other fixed assets as a ratio of total fixed assets.

2. The sum of stocks, debtors, and other current assets as a ratio of total current assets.

3. The sum of fixed assets and current assets as a ratio of total assets.

4. The sum of capital and other shareholder funds as a ratio of total shareholder funds

5. The sum of long term debt and other non-current liabilities as a ratio of total non-current liabilities.

6. The sum of loans, creditors, and other current liabilities as a ratio of total current liabilities.

7. The sum of non-current liabilities, current liabilities, and shareholder funds as a ratio of the variable that reports the sum of shareholder funds and total liabilities.

After I construct these ratios, I estimate their distribution for each country separately, and exclude the outliers by dropping observations that are below

the 0.1 percentile or above the 99.9 percentile of the distribution of ratios. In addition to these filters, I apply further checks:

1. In the balance sheet, the sum of the book value of shareholder funds and liabilities (`SHFUNDLIAB`) and that of total assets (`TOTASSTS`) should be equal to each other. In the same manner, the book value of shareholder funds (`SHFUNDS`) should be either equal or less than that of total assets. I drop firm-year observations if they don't satify this accounting rule.

2. In the income statement (profit & loss accounts), the monetary value of profitability measures such as netincome (`NETINCOME`), cash flow (`CFLOW`), EBIT (`EBIT`) and EBITDA (`EBITDA`) should be less than that of either operating revenue (`OPRE`) or sale (`SALE`). I drop firm-year observations if they don't satify this accounting rule.

A.1.4 Further Quality Checks

After I apply the basic cleaning steps listed above, I check the quality of the variables used in the analysis:

1. Age: I construct the variable "age" of the firm as the difference between the year of the balance sheet information and the year of incorporation of the firm (`DATEINC`) plus one. I drop firms that report dates of incorporation that imply non-positive age values.

2. Total Liabilities: As opposed to listed firms, private firms do not report a separate variable "Liabilities." For these firms, there are three ways to construct liabilities:

(a) Taking the difference between the sum of shareholder funds and liabilities (SHFUNDLIAB) and shareholder funds or equity (SHFUNDS)

(b) Taking the difference between total assets (TOTASSTS) and shareholder funds or equity (SHFUNDS)

(c) Taking the sum of current liabilities (CURRENTLIAB) and non-current liabilities (NONCURRLIAB).

I follow first two options to construct "Liabilities." Either gives the same values. I could also have computed liabilities following the third option. However, I find that there are more missing observations if I follow this approach. Nevertheless, for those observations with non-missing information, I compare the values constructed following first two options with those constructed following the last option. I drop firm-year observations where the values are different from each other by 1,500 PPP dollars.

A.1.5 Winsorization

I winsorize at the 2 and the 98 percentile variables such as logarithm of real sales, logarithm of total assets, collateral, profitability measures, inventory, cash and all debt measures used in the empirical analysis.

A.2 Composition of Debt Measures

1. Current Liabilities **(STDebt)**:
    - Loans **(STFinDebt)**: All short-term financial debts to credit institutions plus part of long term financial debt payable within the year
    - Trade creditors **(TC)**: All debts to suppliers and contractors (accounts payable)
    - Other Liabilities **(STOL):** Other Short-term debt plus other creditors plus income tax payable, social expenditure payable, dividends payable and other current liabilities
2. Non-current Liabilities **(LTDebt):**
    - Total Long Term Interest Bearing Debt **(LTFinDebt)**:
        - Loans: All long-term financial debts to credit institutions
        - Debentures and Convertible Debt
        - Lease Liabilities
        - Other Long-term Interest Bearing Debt
    - Other Non-current Liabilities **(LTOL)**
        - Other Long-term Non-Interest Bearing Debt
        - Provisions including pension fund provisions
        - Preferred Taxes
        - Deferred Revenue

– Minority Interest

→ FinDebt=LTFinDebt+STFinDebt

→ FinDebtSTOL=LTFinDebt+STFinDebt+STOL

→ FinDebtTOL=LTFinDebt+STFinDebt+STOL+LTOL

→ TotDebt=STDebt+LTDebt

→ TOL=STOL+LTOL

Table A.1: Percentage of Firms in Permanent Sample-By Firm Type and Country

Country	Pooled	HU	NL	NO	SE	TR
Period	1999-2013	2004-2012	2000-2012	2004-2013	1999-2012	2005-2012
Panel A: Total Assets						
All	40,016	5,532	191	716	32,895	682
Small	74.8	73.2	2.1	77.4	76.6	18.3
	(29,929)	(4,050)	(4)	(554)	(25,196)	(125)
Medium	19.9	21.1	16.2	17.7	19.3	44.4
	(7,983)	(1,168)	(31)	(127)	(6,354)	(303)
Large	5.3	5.7	81.7	4.9	4.1	37.2
	(2,104)	(314)	(156)	(35)	(1,345)	(254)
Panel B: Employment						
All	38,276	4,547	181	579	32,808	161
Micro	66.4	50.8	6.6	62.7	69.3	9.9
	(25,429)	(2,309)	(12)	(363)	(22,729)	(16)
SMEs	31.3	44.7	44.2	35.2	29.1	57.1
	(11,967)	(2,034)	(80)	(204)	(9,557)	(92)
Large	2.3	4.5	49.2	2.1	1.6	32.9
	(880)	(204)	(89)	(12)	(522)	(53)

To be Continued.

Table A.2: Percentage of Firms in Permanent Sample-By Firm Type and Country

Country	Pooled	HU	NL	NO	SE	TR
Period	1999-2013	2004-2012	2000-2012	2004-2013	1999-2012	2005-2012
Panel C: Age						
All	39,961	5,506	716	191	32,866	682
Infant	8.5	14.7	1.3	80.1	7.4	3.5
	(3,414)	(811)	(9)	(153)	(2,417)	(24)
Adolescent	11.9	14.6	1.1	49.7	11.6	6.0
	(4,759)	(803)	(8)	(95)	(3,812)	(41)
Middle-aged	65.2	70.7	11.6	245.0	64.5	60.0
	(26,036)	(3,890)	(83)	(468)	(21,186)	(409)
Old	14.4	0.0	12.7	0.0	16.6	30.5
	(5,752)	(2)	(91)	(0)	(5,451)	(208)

Notes: Tables A.1–A.2 show the percentages of firms by firm type and country. The firms in each sample refer to ones with non-missing value of the variable on which the percentages are based. In both tables, each cell corresponds to the share of indicated category's number of firms in total economy of the given country-period (%). In Table A.1, shares are constructed based on firm size, and firm size is measured by the logarithm of real total assets and the number of employees, respectively. In Table A.2, firms are categorized based on firm age. In Table A.1, firm size categories are constructed based on predetermined dummies that each equals one if the firm satisfies the criterion for the corresponding firm category at any time during the three years prior to the introduction of LTV ratio cap: Small equals one if the given firm's size is below 75^{th} percentile of the distribution, Medium equals one if the given firm's size is between 75^{th}–95^{th} percentiles of the distribution, and Large equals one if the given firm's size is above 95^{th} percentile of the distribution. Micro equals one if the given firm has employees less than 10, SMEs equals one if the given firm has employees between 10 and 249, and Large equals one if the given firm has employees higher than 250. In Table A.2, Infant equals one if the given firm's age is between 0–2, Adolescent equals one if the given firm's age is between 3–4, Middle-aged equals one if the given firm's age is between 5–24, and Old equals one if the given firm's age is 25 or above. Numbers in parentheses refer to the total number of firms with non-missing value of the variable on which the percentages are based..

Table A.3: Descriptive Statistics: Permanent Sample

Period: 1999–2012
Countries: HU, NL, NO, SE, TR

Variable	Mean	Median	Std. Dev.	25th Pct.	75th Pct.
TotDebt	0.57	0.58	0.25	0.38	0.76
FinDebt	0.14	0.0022	0.2	0	0.24
FinDebtTOL	0.46	0.45	0.24	0.28	0.63
STFinDebt	0.023	0	0.054	0	0.0093
STFinDebtSTOL	0.3	0.26	0.19	0.15	0.4
TC	0.11	0.068	0.12	0.017	0.16
Collateral	0.26	0.16	0.26	0.041	0.44
Sales Growth	0.038	0.023	0.35	-0.082	0.15
Profitability	0.15	0.14	0.15	0.063	0.23
Size	13	13	1.7	12	14
Cash	0.21	0.14	0.21	0.032	0.33
Inventory	0.15	0.05	0.2	0	0.24
Age	2.7	2.7	0.68	2.2	3.1

Notes: Table A.3 reports descriptive statistics of main variables used in the empirical analysis for Full Sample. Debt measures are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit; FinDebt: Total debt excluding trade credit and other liabilities; STFinDebt: Short-term debt from financial institution; STFinDebtSTOL: Short-term Debt excluding trade credit, and TC: Trade Credit. Debt measures are all divided by total assets. Further details on the composition of debt measures are given in the appendix. Collateral is the ratio of total tangible fixed assets to total assets. Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Age is the logarithm of (1+firm age) where firm age in period t that is defined as t minus the date of incorporation plus one. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets.

Table A.4: Composition of Liabilities-By Firm Type

Sample: Permanent, 1999–2012
Countries: HU, NL, NO, SE, TR

	All		Small		Medium		Large	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
(% of Total Liabilities)								
STFinDebt	0.034	0	0.027	0	0.052	0	0.056	0
TC	0.11	0.067	0.096	0.052	0.14	0.11	0.12	0.088
STOL	0.52	0.51	0.56	0.56	0.44	0.39	0.44	0.4
LTFinDebt	0.17	0	0.17	0	0.18	0.032	0.13	0
LTOL	0.077	0	0.072	0	0.072	0	0.16	0.061

Notes: Table A.4 reports descriptive statistics of debt measures by different firm size groups. Debt measures are defined as follows. STFinDebt: Short-term debt from financial institutions; TC: Trade Credit, STOL: Other Short-term Liabilities, LTFinDebt: Long Term Interest Bearing Debt, LTOL: Other Long-term Liabilities, and TC: Trade Credit. Further details on the composition of debt measures are given in the appendix

Table A.5: Cash and Collateral Holdings-By Firm Type

Sample: Permanent, 1999–2012
Countries: HU, NL, NO, SE, TR

	All		Small		Medium		Large	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
(% of Total Assets)								
Collateral	0.26	0.16	0.26	0.15	0.27	0.18	0.27	0.2
Inventory	0.15	0.05	0.13	0.02	0.19	0.14	0.17	0.14
Cash	0.21	0.14	0.24	0.18	0.13	0.07	0.078	0.028

Notes: Table A.5 reports descriptive statistics of cash and collateral holdings by different firm size groups. Collateral is the ratio of total tangible fixed assets to total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Debt measures are all divided by total assets.

Table A.6: Collateral and Firm Leverage: The Impact of LTV Ratio Cap

Sample: Permanent, 1999–2012
Countries: HU, NL, NO, SE, TR

Dependent Variable:	TotDebt	FinDebtTOL	TC	TC	FinDebtTOL	TC	TC
		(divided by total assets)			(divided by total debt)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Collateral×LTV	-0.009***	-0.013***	0.003***	0.003***	-0.006***	0.005***	0.005***
	(-4.915)	(-7.760)	(3.945)	(3.895)	(-4.942)	(4.250)	(4.037)
Cash×LTV				-0.0001			-0.002
				(-0.052)			(-1.547)
Firm Controls	yes	yes	yes	yes	yes	yes	yes
Number of observations	357,622	357,622	348,109	348,109	357,622	348,109	348,109
R^2	0.82	0.79	0.78	0.78	0.75	0.74	0.74
Firm Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Sector×year Fixed-Effects	yes	yes	yes	yes	yes	yes	yes
Country×year Fixed-Effects	yes	yes	yes	yes	yes	yes	yes

Notes: Table A.6 reports the results of the estimation of equation (1.1). In the estimation, I use Permanent sample that covers the firms from Full sample without non-consecutive yearly observations. The dependent variables are different debt measures i.e., TotDebt, FinDebtTOL, and TC. They are defined as follows. TotDebt: The sum of short-term and long-term debt; FinDebtTOL: Total debt excluding trade credit, and TC: Trade Credit. Debt measures are divided by total assets and total liabilities in Columns 1–4 and Columns 5–7, respectively. Further details on the composition of debt measures are given in the appendix. LTV equals to 1 in the year(s) when LTV ratio cap is in place in the corresponding country. Collateral is a dummy variable that equals one if asset tangibility is higher than its median at any time during three years prior to the application of LTV ratio cap. Firm controls are defined as follows: Profitability is the ratio of EBITDA to total assets. Sales Growth is the logarithmic change of real sales. Size is the logarithm of real total assets. Cash is the ratio of cash and cash equivalents to book value of total assets. Inventory is the ratio of total inventories (raw materials+in progress+finished goods) to total assets. Sectors are classified according to four digit NACE Revision 2 codes. Standard errors are heteroskedastic-consistent errors adjusted for clustering across observations of a given firm, and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Appendix B

Appendix for Chapter 3

B.1 Data Appendix

We use permanent and non-permanent samples both for banks and firms. The non-permanent samples are used in regression analysis and in the investigation of cross-sectional patterns. The permanent samples are used for time-series plots.

B.1.1 Bank Selection Criteria

The data is from BANKSCOPE for the period 1990–2010. We exclude the first 6 years and the last year because of poor coverage. We apply the following sample selection criteria to obtain the samples used in the regression analysis:

- We drop central banks.
- We drop banks with faulty records such as inconsistent information on any generic variables: date of establishment/type of company/template etc.
- We drop bank-year observations with negative values of assets/capital/reserves

or deposits.

In addition to the criteria mentioned, we drop banks that do not report total assets continuously for 2000–2009. The sample of European banks has 1123 banks with 11,230 observations while the sample of US banks has 7334 banks with 73,340 observations—both for the period 2000–2009.

For other countries, in addition to above selection criteria:

- We drop countries with less than 20 banks in non-permanent sample.

The final sample has 9437 banks with 85,383 observations for the period 2000–2008.

B.1.2 Firm Selection Criteria

The time period covered in firm-level data downloaded from the ORBIS and AMADEUS databases is 1996–2010, however we exclude the last year because of poor coverage.

- We drop firms with faulty records and firms with inconsistent information on any generic variables such as date of establishment/type of company/template etc.

- We drop firm-year observations with negative values of all types of assets/capital/reserves and deposits.

The following sample selection criteria are applied to obtain the final samples used in the regression analysis:

- We drop firms if any of total assets, current liabilities, and non-current liabilities is missing in all years between 1996–2009.

- We drop firms if any of total assets, employment, sales, operating revenue, current liabilities, and non-current liabilities is negative.
- We drop firms whose total number of employees is lower than 10.
- We drop firms if total assets are less than 100,000 in PPP dollars.
- We drop firms if sales are less than 1000 in PPP dollars.
- We drop firms if operating revenue are less than 1000 in PPP dollars.
- We drop firm-year observations beyond the 0.1% and 99.9% tails of ratios employment/sales,sales/total assets, operating revenue/total assets, and shareholders funds/total assets
- In the data that covers European firms, we drop countries having less than 100 firms for at least 6 years between 1996–2009.
- We drop firm-year observations beyond the 0.1% and 99.9% tails of all leverage measures.
- We drop firm-year observations beyond the 0.1% and 99.9% tails for collateral variable defined as total fixed assets/total assets.
- We drop firm-year observations beyond the 0.1% and 99.9% tails for all profitability measures.

The resulting samples consist of 54,108 firms with 152,124 observations and 234,380 firms with 1,495,671 observations for the US firm-level sample and the European firm-level sample, respectively.

B.1.3 Bank-Level Variables

Total Assets: Total book value of intangible, tangible, and other fixed assets.

Shareholder's Funds: Book value of equity (issued share capital plus other shareholders fund)

Off-Balance Sheet Items: In financial statement of banks, off-balance sheet volumes are listed in three summary lines of acceptances, documentary credits, and guarantees.

Guarantees : Total amount guaranteed by the bank.

Acceptances (reported off-balance sheet): Total amounts the bank "accepts" to pay, usually under international trade finance arrangements where reported off-balance sheet.

Committed credit lines: Total committed and undrawn lines of credit extended by the bank. *Adjusted Assets*: Book value of total assets excluding goodwill and intangibles.

B.1.4 Firm-Level Variables

Total Assets: Total book value of intangible, tangible, and other fixed assets.

Shareholder's Funds: Book value of equity (issued share capital plus other shareholder funds).

Total Liabilities: Total book value of current (all current liabilities of the company such as Loans+ Creditors+ Other current liabilities) and non-current liabilities (all long term liabilities of the company such as Long term financial debt+other long term liabilities and provisions).

B.1.5 Country-Level Data

We use the Barth, Caprio, and Levine data set on Bank Regulation. It provides information on bank regulation and supervisory practice for 107 countries and provides aggregate indexes based on responses to a survey.[1] We use the 2003 values of the following variables: 1) "Supervision Index," which measures the efficiency of supervision and takes a value of 1 if there are multiple independent supervisors for banks and zero otherwise and 2) "Monitoring Index," which measures the efficiency of monitoring and takes a value of 1 if the top ten banks in the country are all rated by international rating agencies, if off-balance sheet items are disclosed to public, if banks must disclose risk management procedures to the public, and if subordinated debt is required as part of regulatory capital and zero otherwise.

[1] For the details on the survey questions and data collection process, see Barth, Caprio, and Levine (2007)

Table B.1: Descriptive Statistics: International Comparison of Leverage Ratios of Banks in US & Europe

	2006			2007			2008			2009			2006-2009
	Aggregated	Mean	Median	Aggregated	Mean	Median	Aggregated	Mean	Median	Aggregated	Mean	Median	N
US	12.7	10.2	10.2	12.9	10	10	11.6	10.2	10.2	9.9	10.7	10.2	7372
Austria	20.5	71.1	16.2	19	60.3	16.3	20.1	63.2	15.4	19.4	50.9	16.9	49
Belgium	15.1	14.3	15.3	12.1	12.2	14	12.6	12.5	12.9	13.2	12.7	12.5	3
Bulgaria	7.9	7.9	7.7	8.4	9.8	8.8	7.4	9.6	9.4	6.1	8.4	7.8	6
Croatia	7.2	9.2	9.9	7.2	9	10.2	6.4	7.6	8.1	6.1	7.1	7.6	6
Cyprus	19.8	19.8	19.8	16.1	16.1	16.1	15.2	15.2	15.2	15	15.3	15.3	2
Czech Republic	3.9	3.9	3.9	4	4	4	4.1	4.1	4.1	5.9	5.9	5.9	1
Denmark	16.6	9.8	7.9	17	10.2	8.3	17.9	11.2	8.6	17.8	11.5	9.8	67
Estonia	12.3	13.5	13.5	11.4	12.8	12.8	10.2	12.2	12.3	11.2	16.9	17.1	4
Finland	20.4	56.5	23.4	22.7	81.2	22.6	30.3	327.1	28.2	25.1	58.3	26.1	4
France	20.7	21.7	12.8	23.8	22.3	12.3	24.4	23.5	12.3	21.3	34.2	11.6	173
Germany	30.7	19.7	17.5	31.7	19.5	17.4	35.8	20.4	17.9	28.5	19.2	17.1	471
Hungary	16.7	16.8	13.9	16.8	17.6	15.1	19.3	18.5	17.3	18.9	16.8	15.7	4
Ireland	9.5	99.1	8.1	11.4	69.1	10.4	12.2	47	11.4	7.1	30.1	6.3	5
Latvia	12.6	11.6	11	10.8	11.8	10	10.3	11.9	12.1	9.6	11.5	11.4	9
Lithuania	16.2	16.2	16.2	14.5	14.5	14.5	13.9	13.9	13.9	14.2	14.2	14.2	1
Luxembourg	27	33.7	24.2	25.1	33.3	24.1	25.1	31.7	25.1	20.2	23.2	18.8	29
Netherlands	3.3	11	10.4	3.6	10.9	9	4	14	10.9	3.5	11.1	9.5	5
Romania	9.7	6.3	5.1	11.4	7.5	6.7	9.8	6.2	4.7	9.4	7.7	9.6	3
Russia	7	8.3	8.1	7.3	8	7.9	8.6	9.2	9	7.6	8.3	8.9	23
Sweden	18.1	23.3	18.7	19.2	24.6	13.8	19.7	18.1	16	19.9	24.4	17.9	11
Switzerland	7.7	14.4	10.5	8.2	13.7	10.4	8.8	13.5	10.8	9.2	13.9	11	179
Ukraine	9.3	8.5	8.4	11.4	11.3	11.3	11.9	11.7	12.1	7.6	11.4	7.7	5
United Kingdom	30.4	17.4	15.6	32.3	18	15.5	32.1	16.7	14.5	16.8	12.5	13.4	67

Notes: Table B.1 reports aggregate, mean, and median leverage ratios and number of banks in U.S., Europe. Leverage is calculated as total assets over equity where total assets is defined as total book value of intangible, tangible, and other fixed assets. Aggregate leverage is calculated as aggregated assets over aggregated equity, with bank-level observations aggregated by the authors. The number of banks reported are lower than the number of banks used in the regression analysis because they refer to the permanent bank sample, defined as banks with non-missing asset data throughout the sample period.

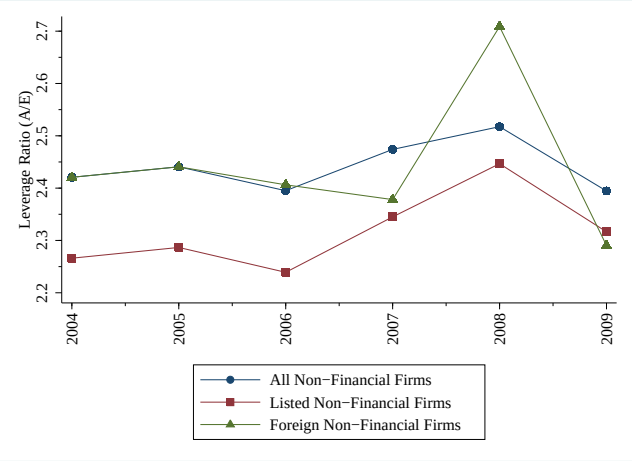
Table B.2: Descriptive Statistics: International Comparison of Leverage Ratios of Banks in the Rest of the World

	2006			2007			2008			2006-2008
	Aggregated	Mean	Median	Aggregated	Mean	Median	Aggregated	Mean	Median	N
Argentina	7.5	6.9	6.7	7.7	7.2	6.5	8.3	7.4	7.2	58
Azerbaijan	12.5	10.4	11.6	11	10.1	10.6	9.7	8.7	9.2	3
Bangladesh	33.8	12.3	16.5	18.8	17.6	15	17	16.1	15.5	11
Brazil	11.6	10	8.8	11.3	10.1	7.7	12.7	10.2	9.1	46
Canada	20.5	20.5	13.1	21.6	18.9	14.1	21.8	28.2	13.4	39
China	44.7	30.8	27.9	-21.8	19	18.3	23.7	20.5	20.8	13
Colombia	7.8	8.5	9.1	8	8.7	9.9	8.3	8.6	9.1	17
Costa Rica	9	9.8	10.9	9.4	9.6	10	9	9.1	9.2	25
El Salvador	8.3	7.9	8.3	8.2	8.4	8.7	7.6	8	8.1	13
Georgia	3.2	3.2	3.2	5.3	5.3	5.3	4.5	4.5	4.5	1
India	14.8	14.8	15.6	15.6	15.2	15.6	13.6	14.8	15.2	63
Indonesia	9.4	8.8	9.7	9.6	8.6	9.3	10.6	9.7	10.2	16
Israel	16.3	17	17.1	15.6	16.3	15.9	16.8	17.6	16.5	7
Japan	18	35.2	18.8	16.8	19.8	18.2	18.5	25.9	19.9	710
Kenya	8.9	8.3	8.7	8.5	7.6	7.8	8	7.6	7.4	12
Korea	14	14.5	14.9	14.1	14.3	15.5	16.4	15.7	16.6	19
Malaysia	12.7	11	12.7	13	11.6	13	12.6	10.8	13.1	31
Mexico	7.7	8	8.5	7.5	8.5	8.5	10.8	13.3	13.4	15
Norway	6.6	10.7	9.4	7.9	11.4	9.9	8.8	11.8	10.7	10
Paraguay	7.9	8	7.9	9	9.3	9.2	8.9	9.3	8.9	12
Peru	10.2	10.1	10.3	11.5	10.9	11.9	12.6	12.4	11.8	13
Slovakia	12.2	18.3	16.2	13.3	17.3	15.8	13.5	19.6	14.1	3
Slovenia	11.8	12.1	12.5	12.2	11.4	11.2	12.5	11.8	11.8	4
Thailand	11.5	13.5	10.8	10.6	27.2	10.1	10.8	13.1	10.8	24
Turkey	9.3	10.7	8.9	8.2	9.3	7.8	8.6	8.7	8.7	11
Uruguay	2.4	2.4	2.4	3.1	3.1	3.1	5.3	5.3	5.3	1
Venezuela	11.8	11.5	11.5	11.3	11.8	11.9	11.1	11.5	11.2	8

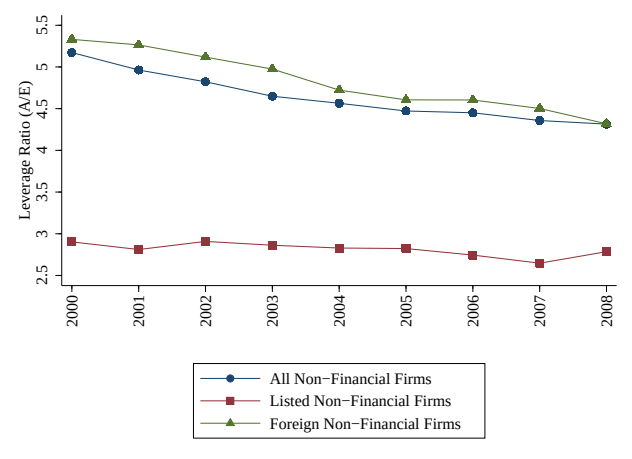
Notes: Table B.2 reports aggregate, mean, and median leverage ratios and number of banks in the countries in the rest of the word. Leverage is calculated as total assets over equity where total assets is defined as total book value of intangible, tangible, and other fixed assets. Aggregate leverage is calculated as aggregated assets over aggregated equity, with bank-level observations aggregated by the authors. The number of banks reported are lower than the number of banks used in the regression analysis because they refer to the permanent bank sample, defined as banks with non-missing asset data throughout the sample period.

Figure B.1: Non-Financial Sector Leverage Ratio

Panel A: ORBIS Micro Data, Mean: US



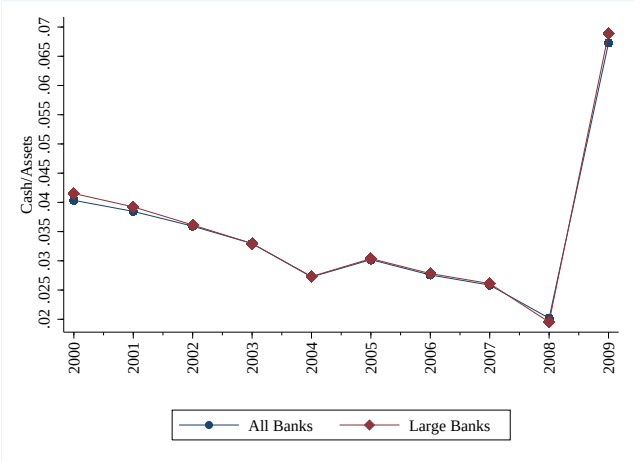
Panel B: AMADEUS Micro Data, Mean: Europe



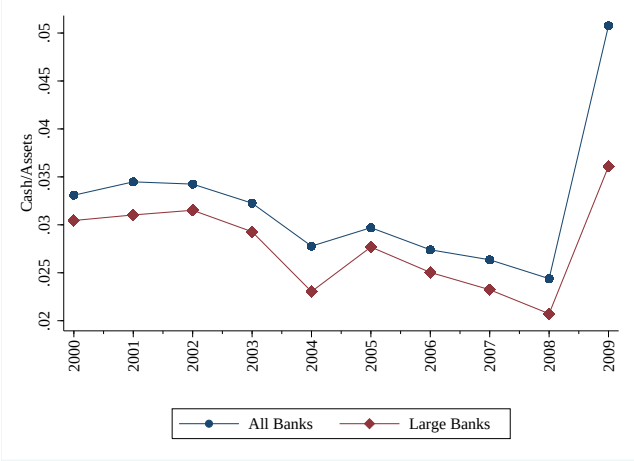
Notes: Panels A and B display mean leverage for non-financial firms in US and Europe, respectively. The leverage ratio is defined as total assets over equity. Non-financial firms refer to all firms, excluding financial firms with Primary NACE Rev. 1.1 sector code J (Financial intermediation). Listed non-financial firms are those listed on a stock exchange. Foreign non-financial firms are non-financial firms which are foreign owned, defined as more than 10% of their voting shares owned by a foreign company.

Figure B.2: Cash Holdings of US Banks

Panel A: ORBIS Micro Data, Aggregate Cash Holdings, US Banks



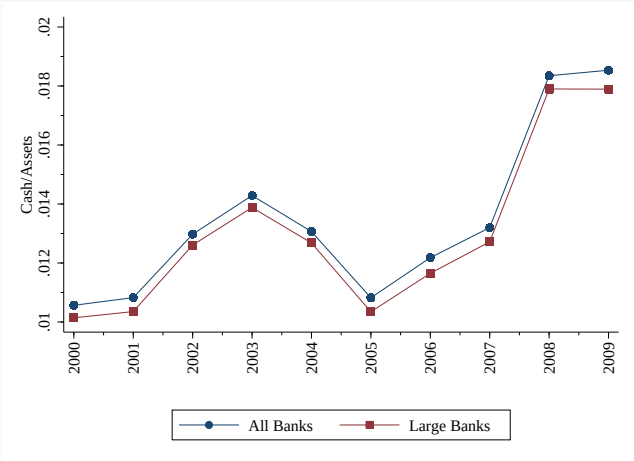
Panel B: ORBIS Micro Data, Median US Bank Cash Holdings



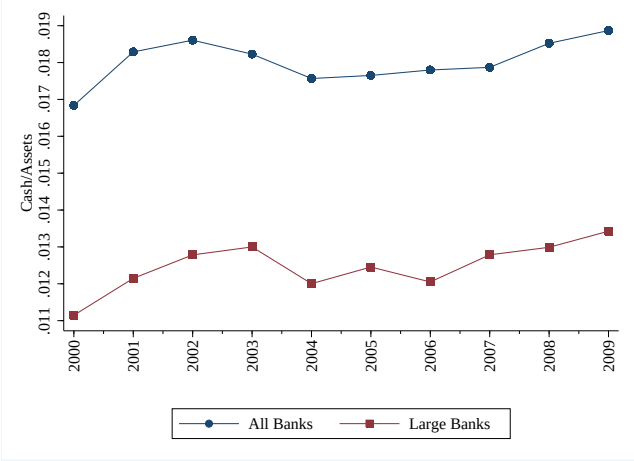
Notes: Panel A displays cash holdings as a ratio of assets for all banks in the US, as well as for large banks, aggregated from bank-level data. Panel B displays the median of the cash holdings ratio for all banks and large banks. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure B.3: (Cont'd.) Cash Holdings of European Banks

Panel A: ORBIS Micro Data, Aggregate Cash Holdings, European Banks

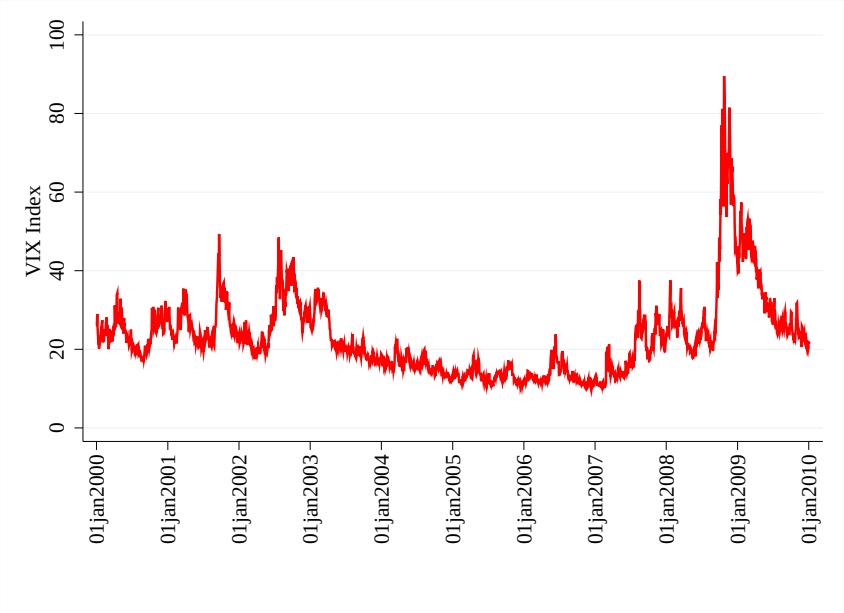


Panel B: ORBIS Micro Data, Median European Bank Cash Holdings



Notes: Panel A displays cash holdings as a ratio of total assets for all banks in Europe, as well as for large banks, aggregated from bank-level data. Panel B displays the median of cash holdings of all banks as well as of large banks. A "large bank" has more than one billion dollars worth of assets in 2000.

Figure B.4: Financial Sector Leverage and VIX



Notes: The figure shows the US VIX index and aggregate US leverage. The VIX index is the Chicago Board Options Exchange Market Volatility Index which measures the implied volatility of S&P 500 index options. A high value corresponds to a more volatile market. Daily VIX data is obtained from the website of the Chicago Board Options Exchange www.cboe.com/micro/vix. The leverage figure repeats Panel B of Figure 3.4.

Curriculum Vitae

Sevcan Yeşiltaş received the B.A. degree in Economics from the Boğaziçi University, Turkey in 2006. She later enrolled in the master program and received her M.A degree in Economics from the Bilkent University, Turkey in 2009. Before enrolling the Ph.D. program at the Johns Hopkins University in 2010, she worked as a Consultant at the National Bureau of Economic Research.

Her research interests lie in the fields of Applied Macro-Finance, International Finance and Corporate Finance. Her research mainly focuses on the investigation of the implications of real-financial linkages at the firm level. Using a comprehensive micro-level data sets, she aims to develop policy implications by testing the predictions of relevant macro models.

Starting September 2016, she will join Koç University, Turkey as an Assistant Professor with a joint appointment in Finance and Economics Department.